For Editorial Contents see page 511

PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION.

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY CHAS. COOPER AND J. FOSTER PETREE.

TEMPORARY OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 18 & 20, COMPTON ROAD, HAYES, MIDDLESEX.

VOL. 150—No. 3911. LONDON: FRIDAY, DECEMBER 27, 1940. Registered at the General Post Office as a Newspaper PRICE 1s. BY FOREIGN POST 1s. 3d.

Engineering Library

JAN 23 1941

Air Receivers Buoys, Road Wagons Tanks. **TANKS** Hoppers, Chimneys, Ducting.
EVERYTHING FROM MILD STEEL PLATE.
JOHN BELLAMY
EAST 1892 LIMITED. Est. 1860
MILLWALL E.14 1216

J. & E. HALL REFRIGERATION
FOR LAND & MARINE PURPOSES
LIFTS AND ESCALATORS
J. & E. HALL LTD., ENGINEERS, DARTFORD, KENT.
Telephone: Dartford 3456.
London Office: 10, ST. SWITHINS LANE, E.C.4.
Telephone: MANSION HOUSE 9811. 1263

PATTERNS
WOOD & METAL.
B. LEVY & CO. Osbert St., S.W.1 Vic. 1073

METAL SLITTING SAWS
GROUND FLAT STOCK
WILLIAM WARD & SON (SHEFFIELD) LTD.
CENTENARY WORKS, WOODSEATS ROAD, SHEFFIELD. 712

SECTIONAL PRESSED STEEL TANKS
also
RIVETED and WELDED PLATEWORK
STORAGE TANKS, BUOYS, CHIMNEYS, BUNKERS, HOPPERS, Etc.
BROWN, LENOX & CO.
(LONDON), LIMITED.
Contractors to the Admiralty since 1808.
MILLWALL LONDON, E.14.
Telephone: East 0700/1. 830

GLOVES
For Steelworkers, Stokers, Miners, Welders. Women's munition gloves in Chamois or Leather
MACPHAIL & KAY Ltd.,
WOODLEY, Nr. STOCKPORT.
See last week's ¼ page.

FOR HIGH CLASS
PATTERNS & MODELS
Phone: EUSton 3176 (4 lines)
GEORGE WAILES & CO. LTD.
382-8, EUSTON RD., LONDON, N.W.1.
Specialists since 1855 669

LOCOMOTIVES
STEAM OR DIESEL
HUDSWELL CLARKE & Co. LTD.
RAILWAY FOUNDRY, LEEDS.
London Office: 46, Victoria St., S.W.1.
Telephone: Victoria 1133 8559

SPENCER - BONECOURT
Patent Waste Heat Boilers
32, Farringdon Street, London, E.C.4. 868

YARROW
& CO. LTD.,
GLASGOW
SHIPBUILDERS
MARINE ENGINEERS 848
LAND AND MARINE BOILER MAKERS

PETER BROTHERHOOD
PETERBOROUGH LTD.
STEAM ENGINES AND TURBINES,
GAS AND OIL ENGINES,
AIR COMPRESSORS,
REFRIGERATING PLANT.
See advertisement, Page 29, Dec. 20 6938

SPRINGS
FOR ALL PURPOSES 1137
WILLFORD & CO. LTD.,
PARK HOUSE WORKS, SHEFFIELD, 9

DREDGERS
OF ALL TYPES
FERGUSON BROS. (Port-Glasgow) LTD.
PORT-GLASGOW. 1078

FORGINGS.
WALTER SOMERS, LTD.,
HALESOWEN 7116

WAGONS
HURST, NELSON & CO., LTD.,
MOTHERWELL 3382

SPECIAL MACHINES
MADE TO ORDER
Parts and repairs
Erection of Plant
Millwrights work 952
THOMAS HUNT & SONS
Westbridge Road, BATTERSEA, S.W.11.

ELEVATORS
BARRY, HENRY & COOK, LTD.
780

TWIN DISC CLUTCHES
BRITISH TWIN DISC & CLARIFIERS LTD.,
BUSH HOUSE, ALDWYCH, LONDON, W.C.2
1268

Trepanning machine for tube plates, three 3½ in. spindles. Admits plates 10 ft. 6 in. by 8 ft. 6 in. Table size, 8 ft. 6 in. by 7 ft. Traverse, 8 ft. CII. seat for motor. Makers, Campbells & Hunter.—Apply Danks of Netherton, Ltd., Netherton, Dudley, Worcs. J 292

Research Engineers, Ltd., Northampton Grove, Canonbury, London, N.1. Design and construction of mechanical and electrical machinery and apparatus. Experimental work of any description. We have also a department for repetition work and precision machining at competitive prices. 1071

RAPIER
Builders of Europe's Largest
EXCAVATORS
RANSOMES & RAPIER, LTD
IPSWICH 1016 ENGLAND

CRADLEY BOILERS
CRADLEY BOILER CO., LTD., 1088
CRADLEY HEATH, STAFFS.

MUREX Electrodes
1107
MUREX WELDING PROCESSES LTD.,
HERTFORD RD., WALTHAM CROSS, HERTS.

MACROME treated **TOOLS** do more work in less time
MACROME
LIMITED
Z Dept.,
ALCESTER, WARWICKSHIRE, ENG.
Phone: VIC. 1283-4.

CRANES
GEORGE RUSSELL & CO., LTD.,
Motherwell. 816

PATERSON
SPECIALISTS
IN ALL FORMS OF
WATER TREATMENT
FOR
MUNICIPAL
AND
INDUSTRIAL
PURPOSES 780
83, KINGSWAY, LONDON

AILSA CRAIG DIESELS
AILSA CRAIG LTD., 242, Strand-on-Green, Chiswick, London, W.4.

Alfred Herbert Ltd., Coventry PAY BEST PRICES for SECONDHAND MACHINE TOOLS in good condition, by first-class makers.—Write, wire, or phone, and our representative will call. 'Phone 88781 Coventry. Telegrams LATHE, Coventry. W 305

On Active Service
COOPER SPLIT ROLLER BEARINGS
KING'S LYNN 1158 NORFOLK

LIGHTALLOYS LTD.
FIRST QUALITY
ALUMINIUM CASTINGS
ALPAX WORKS, St. Leonard's Road, Willesden Junction, London, N.W.10. Telephone: Willesden 3460-1-2. Telegrams: "Lightalloys-Phone-London."

WATER PURIFICATION PLANT
OF EVERY DESCRIPTION
JOHN THOMPSON
(KENNICOTT WATER SOFTENERS) LTD.,
WOLVERHAMPTON

TAYLOR AND CHALLEN POWER PRESSES
TAYLOR AND CHALLEN LIMITED. 1172
DERWENT WORKS, BIRMINGHAM, 19.

VISCO
AIR FILTERS
DUST COLLECTORS
COOLING TOWERS 1128
THE VISCO ENGINEERING CO., LTD.
Stafford Road, Croydon. Phone: Croydon 4181/5

SAMUEL PLATT
LIMITED
King's Hill Foundry, Wednesbury, Staffs.
DRAWBENCHES
FOR
AIRCRAFT WORK 689

ALLDAYS & ONIONS
1132 BIRMINGHAM. LTD.
SMITHY PLANT

"The machine with a BRAIN"
SCIAKY
SPOT WELDERS
SLOUGH 22342

"MAVITTA"
DRAFTING MACHINES
for all boards.
(British Made.) 996
THE MAVITTA DRAFTING MACHINES LTD.
Anchor Works, Park Rd., Aston, Birmingham 6.

SEE PAGE 21

DECEMBER 27, 1940. —— ENGINEERING. —— VOL. 150, PAGES 501—520

ARMSTRONG-WHITWORTH

PNEUMATIC TOOLS

have an International reputation for excellence, whether for use in Rolling Mills, Railway Workshops, Shipyards, Foundries, Contracting or General Engineering Works. The Armstrong-Whitworth range is comprehensive enough to make the most suitable tool available for any specific operation, and detailed enquiries will receive careful and skilled attention.

"Armstrong - Whitworth Rotary Air Grinders cover operational requirements from die sinking and other precision grinding with mounted points to high powered machines capable of the heaviest duties called for from a Portable Grinder in Foundries or Rolling Mills; in addition Rotary Sanding Machines and Surface Grinders are included."

THE MACHINING OF ABRASIVE TIMBER.

By P. HARRIS, B.Sc. (Eng.).

FIREPROOFED timber, impregnated and compressed wood, glued laminated stock and certain species of timber have a considerable abrasive effect on tools, especially when machined under conventional conditions. Cutting edges need frequent regrinding, which not only wastes metal but reduces output through the time lost in changing tools. For various classes of sawing, grooving, rebating and similar operations, greatly improved results can be obtained by using tungsten-carbide tips on the saw teeth or cutters. Owing to expense and difficulties in manufacture, the use of this tipping is generally restricted to relatively small diameter circular saws, short cutters and special forms of solid circular cutter heads. In other cases, the ordinary types of wood-cutting tools have to be employed and they are capable of reasonably good service on abrasive material, provided the cutting conditions are suitably modified. Information has been lacking concerning the mechanism of blunting and its relation to cutting and feeding speeds, tool shape and other factors. Research into these matters has been instituted, therefore, at the Forest Products Research Laboratory and an account of a recent study is given below.

The object of the investigation was to determine the influence of the rate of feeding on cutter wear and energy consumption in planing. It was carried out on Queensland walnut (*Endiandra Palmerstonii*), a timber having a uniform and fairly severe blunting effect on tools, thus making it well suited for the work. Thin high-speed steel knives of best quality were used on a power-fed planing machine, at standard values of cutting angle and grinding angle, a series of tests being made at different feed speeds. An important requirement in this study was fine and accurate measurement of the wear of the cutting edges. Preliminary experiments, employing various optical and mechanical devices, showed that the most satisfactory method was to base measurement on the decreasing projection of the cutters from the cutter-block cylinder, in a direction parallel to their cutting faces. For this purpose, an instrument incorporating a dial gauge graduated in ten-thousandths of an inch was constructed. Its use enabled the projection to be measured at definite positions along a cutting edge. By this means, the progressive wear of the four cutters on the block was recorded throughout each test.

For analysis of the results of the tests, it was necessary to take into account the fact that, as wear occurs, an increasing amount of metal is removed from the cutter per unit decrease in projection. A curve showing the loss in linear projection in relation to the number of feet of timber planed does not provide a true picture of the dulling effect of the wood. The corresponding volumetric wear on the cutters must be determined, and for this purpose information regarding the progressive change in shape of the cutting edges was needed. Impressions of the latter in a plastic material produced satisfactory records of the changing profile. A convenient technique was evolved and series of impressions were examined and measured with the aid of a microscope and *camera lucida*, also by means of micro-photography.

The profile of a cutting edge, partly dulled, is shown in Fig. 1. It will be noted that wear occurs at the cutter face near the edge, where the separated wood is deflected. The edge becomes slightly rounded and the lower portion of the cutter does not correspond to the cutting circle, as would be the case if there were a "jointing" effect, but is inclined upward from the rear. This inclined lower portion is largely responsible for the tendency of the wood to "ride" on the cutters when they become dulled. It provides also an explanation for the compression effect on the machine finish and for the manner in which the power consumption increases. When a cutter is sharp, there is a definite boundary to the narrow zone of wood subjected by the cutting edge to the intense pressure required for separation and a clean rupture occurs along this line. As the edge wears away, the failure is no longer localised and crushing is distributed over an increasingly large area of wood, not only in the immediate vicinity of the edge but below the inclined portion of the tool. The force required to produce the critical crushing stress necessary for the separation increases as the dulling progresses, with a corresponding rise in the power consumption. The crushed wood below the plane of separation recovers partly after the cutter has moved forward, but the cut surface is roughened by the crushing. Further expansion of the wood is likely to occur, particularly if there is change in moisture content, and the surface may become ridged or have other irregularities.

It was possible to represent the typical shape of the dulled knife-edges by a geometrical figure and a formula was obtained relating the volumetric wear per inch length of cutter to the decrease in linear projection. The formula is as follows:—

$$V = \frac{p^2}{2}\left[\tan\beta + k^2\tan\gamma + (l - \sec\beta)^2 \cdot \frac{\cos(\alpha+\beta-\delta)}{\sin(\alpha-\delta)} \cdot \cos\beta\right]$$

where V = volumetric wear per inch length of cutter = area A C H G D (Fig. 1).
p = loss in linear projection = A B.
α = cutting angle.
β = grinding angle of cutter.
γ = angle of wear at cutter face.
δ = angle of wear at base.
$k = \frac{B\,C}{A\,B}$.
$l = \frac{A\,D}{A\,B}$.

Average values of the factors, k, l and the angles γ, δ were determined by the method described, and, for the particular cutting and grinding angles used, the formula became $V = 0{\cdot}484\ p^2$. The curves in Figs. 2 and 3 indicate the influence of feed speed, in relation to output, on cutter wear as calculated on this basis. In both cases the material planed was *Endiandra Palmerstonii* with 12 per cent. moisture, a four-knife cutter-block was used, the depth of cut was 0·060 in., the diameter of the cutting circle was 6⅜ in., the spindle speed 3,500 r.p.m., the cutting angle 30 deg., and the grinding angle 35 deg. Curve A, in Fig. 3, shows the relationship of lineal output to feed speed at 10^{-6} cub. in. wear per inch of cutter length, and curve B the relationship of volumetric wear per inch of cutter length to feed speed at 200 ft. lineal output. It will be noted that, for a given amount of dulling, there was a marked increase in the quantity of timber planed, as the rate of feeding was raised. For example, increasing the feed from 30 ft. to 60 ft. per minute, permitted 367 lineal feet of timber to be planed instead of 138 ft. for 10^{-6} cub. in. volumetric wear per inch length for each cutter. The explanation for this improved performance is as follows:—The blunting of a cutting edge is due to wear through rubbing, or scraping, before the edge completely enters the wood and to that occurring under the intense pressure needed for separation during the actual cut. If initial rubbing could be avoided, the cutting edge should be capable of travelling a definite total distance in the wood before a given amount of cutter wear was produced, depending on the particular qualities of the steel employed and of the wood. This "edge-wear travel" of the cutter would be the product of the distance travelled in the wood per cut and the number of cuts made before the specified blunting occurred. The maximum output of machined timber for the cutter travel would be obtained by removing as much wood as possible at each cut. In the tests, there was only a little variation in the amount of

Fig. 1.

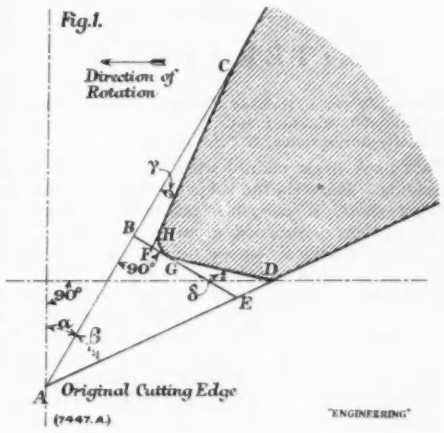


Fig. 2.

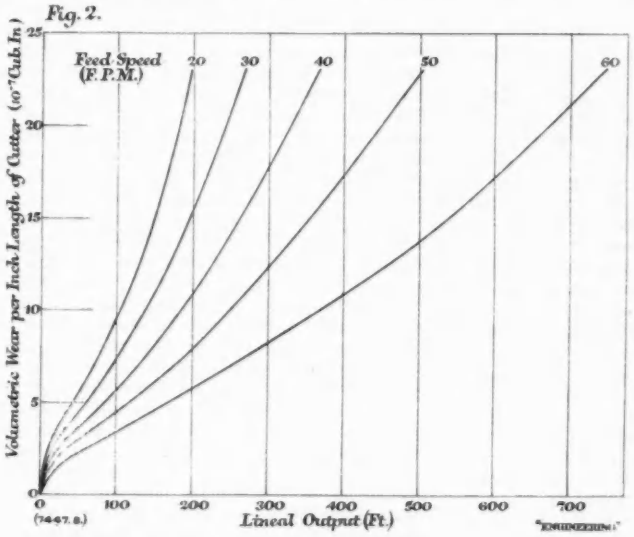
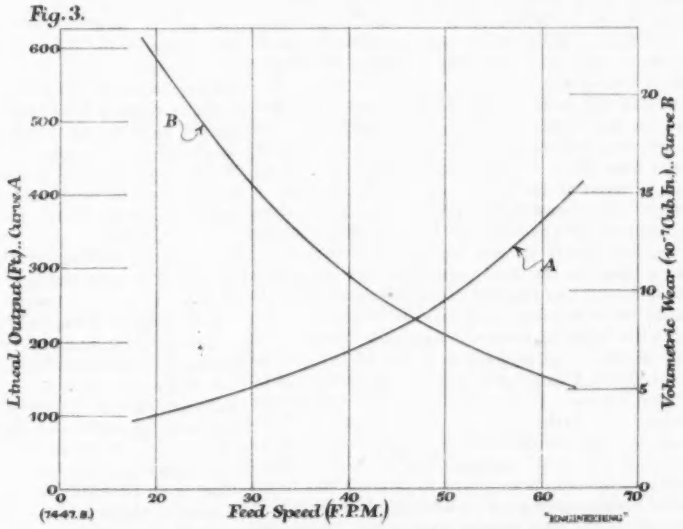


Fig. 3.



wear on the cutter face for different feed speeds. It would appear, therefore, that the thickness of the wood deflected during each cut does not influence to any great extent the rate of blunting. Increase in feed speed, resulting in the removal of thicker chips, with only a small effect on the distance travelled by the cutter in the wood, would produce a marked improvement in the output for the given wear. In addition, such modification increases the angle between the successive trochoidal cutter-paths, where they intersect at entry, and the cutters are less liable to rub before entering the wood. The importance of this factor is shown in the previous example. The output was 138 lineal ft. at 30 ft. per minute and approximately twice this amount could be expected for an equal "edge-wear travel," when the feed rate was doubled. The fact that not 276 ft. but 367 ft. were machined indicates that the additional 66 per cent. in output was due to the reduction in initial rubbing. It is of interest to note that, for the volumetric wear of one-millionth of a cubic inch, each of the cutters was able to make 21,400 cuts when the feed speed was 60 ft. per minute, in comparison with 16,100 cuts at 30 ft. per minute. As the calculated travel in the wood per cut was 0·627 in. and 0·611 in., respectively, the total distances travelled by each cutter were, in the two cases, 1,117 ft. and 819 ft. for the wear specified.

There are further advantages in raising the feed speed. Experiments have shown that the electrical energy consumption per square foot of timber planed is reduced as the feed speed is increased. The reason is that though more power is required at the faster rate of feeding, it is being used for a shorter period, and the amount of extra power is comparatively small in proportion to the reduction in time. With abrasive material, energy consumption increases as dulling progresses, and comparison of the effect of different feed speeds has to be based on mean values of the energy required per square foot of timber for an equal amount of wear. The results of the tests on Queensland walnut showed that, on this basis, approximately 40 per cent. less energy was absorbed when the feed speed was raised from 30 ft. to 60 ft. per minute. Machining time is saved at the higher rate of feeding, but a coarser cutter-marking is produced. Apart from the capacity of the machine for working at faster feeds, the quality of the finish that is acceptable sets a limit to the feed speed, for the particular spindle speed and number of cutters employed. It should be mentioned that these tests were carried out with what is termed "one-knife finish." A very slight excess projection of one of the cutters on a block will cause it to remove the cutter marks of the others; thus coarsening the finish, but having very little effect on the amount of work done by the various cutters. Calculation shows that only one or two thousandths of an inch difference in projection is sufficient to produce this result under normal machining conditions. It is extremely difficult to set long cutters to such fine limits, and even so, changes usually occur in the respective cutting circles of the cutters owing to distortion of the block, or other cause, when it is revolving at high speed. The usual remedy is to remove any irregularity in projection by "jointing" the cutters, *i.e.*, lightly stoning the cutting edges as they revolve, by means of an emery stick moved along a slide parallel to the cutter cylinder. Jointed cutters tend to blunt rapidly, however, when used on abrasive timber, unless the heels, formed by the stoning process, have been removed by careful honing or position-grinding. Provided the necessary care were taken to obtain equal cutting, further improvement in output could be gained by increasing the number of cutters, as a faster feed could be used. For instance, if six cutters were used instead of four, the feed speed could be raised by 50 per cent., with the same finish being produced. The use of higher spindle speeds brings in complications, and is not to be recommended, but it would allow a corresponding increase in feed speed and thus improve the output per period between sharpenings.

The results of this investigation may be summarised as follows:—The wear on a cutter is caused through the initial rubbing of the cutting edge before complete entry into the wood and that occurring under the intense pressure needed for separation and deflection of the chip. The best output from a cutter, before resharpening is necessary, can be obtained by minimising the initial rubbing and arranging for the maximum amount of wood to be removed at each cut. This result can be attained by using feed speeds as rapid as the finish and the capacity of the machine permit. The use of fast feed speeds in machining abrasive material provides longer service from tools, increased production and reduced energy consumption.

The work described above was carried out as part of the programme of the Forest Products Research Board, and is published by permission of the Department of Scientific and Industrial Research.

LITERATURE.

Philips Practical Welding Course. London: Philips Industrial (Philips Lamps, Limited), Century House, Shaftesbury-avenue, W.C.2. [Price 3*s.* 6*d.*]

THIS book deals mainly with the actual craft of welding. It covers the subject briefly, but widely; being short, it describes rather than discusses. The author, with good grounds, regards welding as a metallurgical process and it is approached from that aspect. A whole chapter is devoted to the manufacturing processes for cast and malleable iron and mild steel, and some pages to the elements of metallography. Welding plants for alternating and direct current, and non-electrical processes, are noted briefly. The usual methods of welding mild steel, sequence of runs, and voltage regulation, naturally take considerable space, and there is a short but good note on plastic distortion. The chapter dealing with the welding of cast iron is one of the best in the book. This section also has chapters on the welding of alloy steels and non-ferrous metals. Finally, there is a chapter on costing, based on the cubical contents of welds.

Some readers may think that more importance should be attached to a sealing run on the reverse side of single Vee-joints, wherever this is possible. Trusting to the use of different voltages and electrodes for the first run is sound theory, but is giving a hostage to the "human factor." It would also be difficult, surely, to justify the statement that the arc-welding process usually eliminates the necessity for preheating when welding cast iron. Mention is made of special shapes of rolled sections for welded steelwork, but in this country the scheme is not popular and, perhaps, as yet, is not even desirable. An appendix gives details of one particular make of electrodes, and summarised welding data which will be useful in estimating the time required for work, and the number and quantity of electrodes. Some mathematical tables and a list of official publications complete a useful section. This is an excellent book for those who must have a working knowledge of the craft of welding.

Methane. Its Production and Utilisation. By DR. J. P. LAWRIE. London: Chapman and Hall, Limited. [Price 6*s.* net.]

THE possible application of methane as an alternative fuel to petrol is of considerable interest under war conditions, and the evidence in favour of extending its use in this capacity is strong. Scientific research, and the results obtained on pilot plants, indicate that the extensive development of methane should go far to relieve the demand for imported fuel. It is already used as an alternative to petrol in a number of Continental countries. In this small volume, Dr. Lawrie surveys the whole field of the use of methane as a fuel in internal-combustion engines. The general scope of the book is closely parallel with that of the report of the Gas Traction Development Committee, printed in abridged form on page 456, *ante*, many of the statements and arguments being common to both publications—a similarity which is explained by the fact that the author was formerly one of the joint honorary secretaries of the Committee. In the book, however, he has been able to discuss the subject rather more fully, and presents a strong case for the wider utilisation of methane, especially the large volumes hitherto allowed to go to waste.

DEVELOPMENTS IN WOOD TECHNOLOGY.

By DAVID BROWNLIE.

(*Concluded from page* 462.)

THE "exploded wood" process, the invention of W. H. Mason, originated in the United States about 1924, and was introduced on a commercial scale in 1925 by the Masonite Corporation, at Laurel, Mississippi, whom I have to thank for their courtesy in supplying information and the accompanying photographic illustrations. In general, the process consists in subjecting disintegrated wood, including sawdust, chips, and ends and pieces, to very high steam pressure (about 1,000 lb. per square inch gauge) for an exceedingly short period, such as 5 seconds to 10 seconds, and suddenly releasing the steam to atmospheric pressure. As a result, the wood is "exploded" into its constituent fibres, forming a pulpy mass, which is then made into a thick wet lap on a modified Fourdrinier paper machine and pressed in steam-heated hydraulic presses at very high pressure, giving a hard sheet or "board," available in a considerable range of qualities and thicknesses. Because of the enormous development that has taken place, the sawdust and other waste wood originally used could not be obtained in sufficient amount at a reasonable cost (because of transport) so that a large proportion of ordinary wood is now used for the purpose, chiefly pine and hardwood. The Masonite Corporation, however, who own about 120,000 acres of forests, adopt, as far as possible, the principle of using the non-timber portion of the tree, on the same lines as for wood pulp.

The process is carried out in what is termed an "explosion" gun, consisting of a small high-pressure vertical forged-steel cylinder, illustrated in Figs. 3 and 4, opposite, with a hopper or cone-shaped bottom. The cylinder is 6 ft. 8 in. high, 1 ft. 8 in. in internal diameter, and of 10 cub. ft. capacity, with walls 4 in. thick, and a heavily bolted top cover. Waste wood of all kinds can be used, including bark and roots, and is chipped down to about $\frac{3}{4}$ in. size and screened to give a product of $\frac{3}{8}$ in. to 1 in., the dust and smalls being used as fuel and the over-size returned to the chippers. The screened material is charged, from a hopper over the top, into the "gun," which is almost filled, and saturated steam at 600 lb. pressure is then admitted at the bottom, the charge being kept under these conditions for about 30 seconds. This constitutes the preliminary operation. Steam is supplied from a super-pressure boiler plant operating at 1,200 lb. per square inch, with superheaters; the charge reaches 1,000 lb. per square inch, or slightly over, and 540 deg. F. in about two seconds, after which the contents are suddenly discharged to atmospheric pressure. The equipment includes hydraulically-operated inlet and discharge valves with automatic control, giving the correct cycle of operations, which takes less than 60 seconds from the charging of the wood to the discharging of the exploded wood.

In the standard process, a battery of explosion guns is connected to a common discharge main leading to washers with agitators, using hot water at about 160 deg. F., and giving a pulp (fibre) mixture containing some 50 per cent. moisture, with, however, some fibre aggregates or bundles. The pulp is then "refined" in centrifugal refiners, consisting of cones revolving at about 1,800 r.p.m., so that the heavier fibre bundles are thrown to the outside and separated, being returned to the process. The refined pulp, suspended in water in a proportion of about 1 : 50, is passed to the paper machine, shown in Fig. 5, on Plate XXXV, which includes pressure rolls, and is made into a wet lap, $\frac{3}{4}$ in. to 2 in. thick, according to the final product desired. This wet lap contains about 60 per cent. moisture. In some cases, the pressure rolls are steam-heated, which results in the formation during subsequent operations of a denser "skin" on the outside.

As the wet lap discharges continuously from the machine it is automatically cut off into lengths of 12 ft., which are passed by wire conveyors to a

THE DEVELOPMENT OF WOOD TECHNOLOGY.

(*For Description, see Page* 502.)

FIG. 5. PAPER MACHINE FOR MAKING WET LAP: MESSRS. MASONITE CORPORATION.

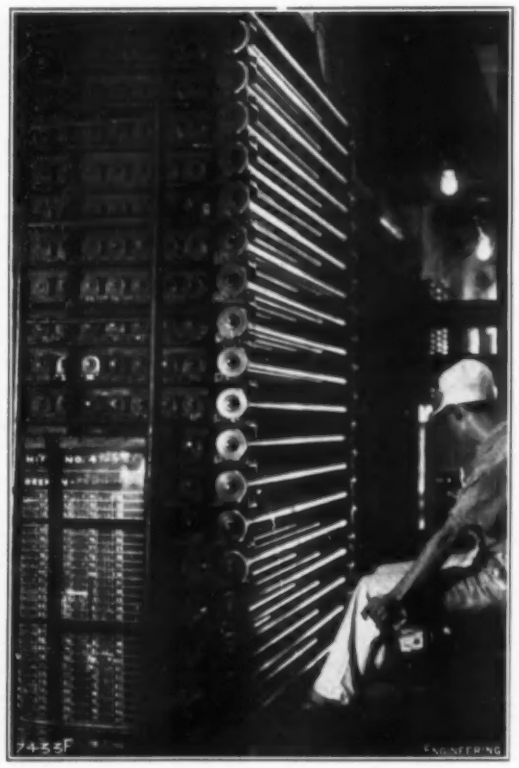


FIG. 6. STACKING WET LAP AFTER CUTTING.

FIG. 7. PRESSING WET LAP.

(*To face page* 503.)

UNIV. OF MICH.

DEVELOPMENTS IN WOOD TECHNOLOGY.

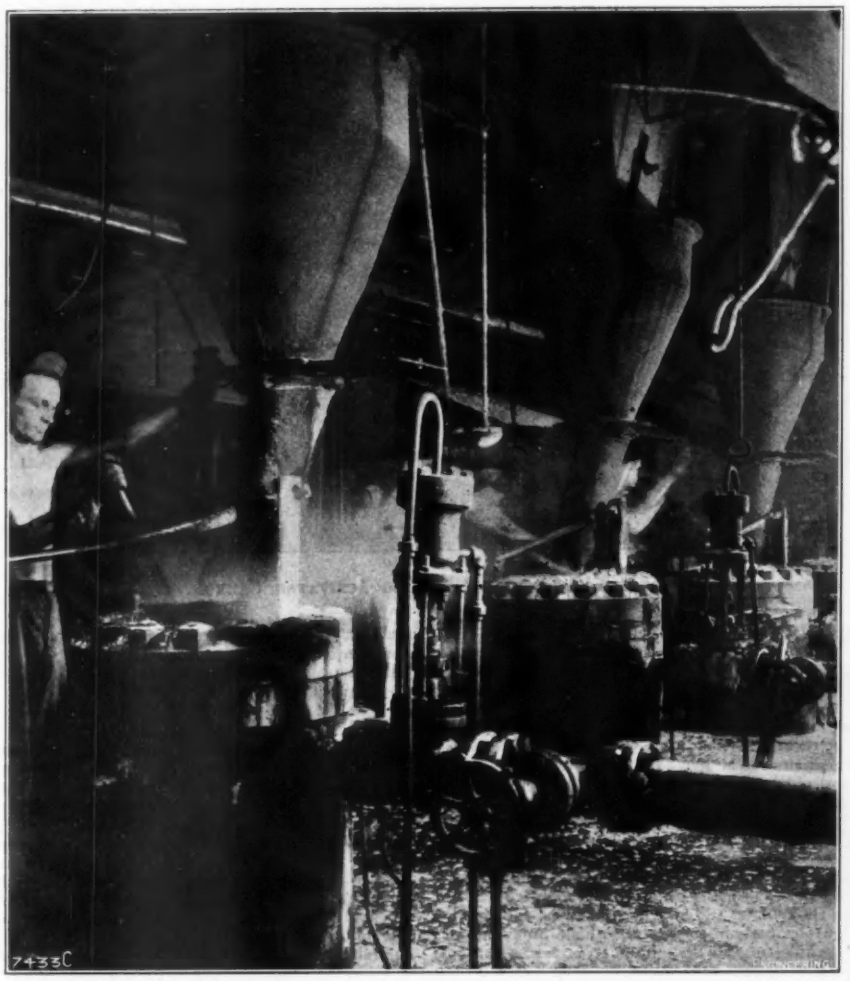


FIG. 3. BATTERY OF "EXPLOSION" GUNS FOR WOOD.

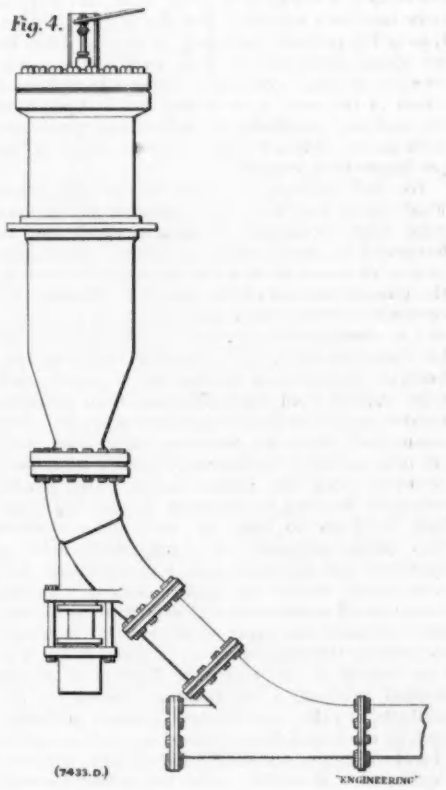


Fig. 4.

stationary rack in a framework holding 20 sheets, one above the other, as shown in Fig. 6, Plate XXXV. Each rack frame, when filled, is then conveyed to large steam-heated hydraulic presses, illustrated in Fig. 7, Plate XXXV. In the very large plant at Laurel a rack is filled with 20 boards, each 12 ft. by 4 ft., every two minutes. The hydraulic presses have a series of platens or pressing plates about 12 ft. 6 in. long and 4 ft. 6 in. wide to take the wet laps, and the operating conditions, including the pressure used, the duration of the pressing, and the temperature of the steam, are varied according to the exact nature of the product required. The steam for heating is used within the range of, say, 250 lb. to 400 lb. per square inch gauge pressure, while in some cases the pressing may take 30 minutes, with pressures as high as 2,500 lb. per square inch. The nature of the steel platens affects the surface of the finished material. For one standard product, known as "Presdwood," chromium-plated platens are used, generally at about 1,700 lb. per square inch pressure; and the durations of pressing may range from 12 minutes to 25 minutes, according to the thickness of the sheet, $\frac{1}{8}$ in. and $\frac{5}{16}$ in. being two standard thicknesses. For different qualities of material, such as "S2S" and "Temprtile," pressures up to 2,500 lb. per square inch are required, whereas, for "Insulation" board, a lower pressure and temperature suffice.

All the different varieties are discharged from the presses very hot and absolutely dry. They are allowed to cool and also to "condition," generally by being sprinkled with water so that they take up the natural amount of moisture, about 7 per cent., depending upon the humidity of the atmosphere. The varieties made represent a considerable range as regards specific gravity; for example, from 0·32 to 1·025. Special lignin plastics are also manufactured, including "Benalite," which has a specific gravity as high as 1·45; while, at the other end of the scale, is an extremely light and cellular material known as "Cellufoam," in which the separated fibre is mixed with a frothing agent before being passed on to the paper machine.

In general, all these varieties of "Masonite" made from the disrupted fibre of wood (which, however, has been partly decomposed chemically, especially as regards the ligno-cellulose content) have an extremely uniform "no-grain" structure, much superior to that of the original wood. Mainly, they are used in competition with not only wood, but often with such products as steel and asbestos-cement composition, for panels, walls, boards, laths, ceilings, tiles and flooring material, for buildings, railway coaches, motor vehicles, and ships.

The plant at Laurel has now a total annual productive capacity of 400,000,000 sq. ft. of finished material, of various thicknesses, over 1,700 persons being employed. For this output, a total of 162,000 United States cords (20,736,000 cub. ft. of stacked wood) are required. This production involves the use of about 1,284,000,000 lb. of steam per annum, the boiler plant being fired by natural gas. The 1,200-lb. per square inch boiler, installed in 1925, was one of the first in the world to use super-pressure steam for process work. Since 1930, a large number of industrial establishments, especially in the United States and Germany, have adopted super-pressure steam both for process work and power generation. It is a strange circumstance that, at the present time (whatever may be the position a few months hence) super-pressure steam at 1,500 lb. to 2,500 lb. per square inch is regarded as being more suitable for industrial establishments using process steam, with pass-out turbines, than for power stations with condensing turbines. The reason is that, in the latter case, the extra thermal efficiency, as compared with, say, 900 lb. to 1,250 lb. per square inch, is hardly sufficient compensation for higher capital, maintenance and repair costs. With pass-out operation, however, the case is very different, since the much-increased overall thermal efficiency from the boiler to the final place of use is decidedly a commercial proposition.

Several other "Masonite" plants are operating in different countries. In 1929, a plant was started up at Rundbiksverken in Sweden, by the Masonite-fabriken Rundbiksverken, which originally had a production of 125,000 sq. ft. of material per 24 hours, and has since been doubled in size. Following this, a plant was erected in Italy, in 1937, at Bolzano, near the Brenner pass, by the Societa Anonima Feltrinelli Masonite; while, in 1938, the Masonite Corporation (Australia), Limited, erected a plant in Australia at Raymond Terrace, New South Wales. A fourth plant, owned by the Masonite Company of Canada, Limited, commenced operation in 1939, at Gatineau, Quebec. The total capacity of the five plants is approximately 582,500,000 sq. ft. of board material per annum, of which Laurel represents 68 per cent., as indicated previously.

Since 1938, the highly important discovery has been made that, in the operation of "exploding" wood and washing the pulp, the large amount of hexosans, pentosans, and other sugar-like products formed by the hydrolysis of the hemi-celluloses, and the partial hydrolysis of the ligno-celluloses, can be recovered. By this new modified process, just recently placed in commercial operation, the exploded pulp, instead of being washed with water, is first squeezed to remove the liquid, which is a strong solution of the sugars and other products, quite different from the very dilute solution that results by direct washing with water, and, therefore, can be recovered at a reasonable cost. The solids obtained by evaporation of the strong solution consist of 70 per cent. of sugars; that is, galactose, glucose, mannose, and other hexoses, as well as pentoses such as arabinose and xylose. The plant at Laurel is believed to have the large productive capacity of about 75 short tons of sugars per 24

hours, and it is stated that methods have been developed for separating the various sugars and using the pentose sugars as raw material for the production of formic acid, acetic acid, and furfural (now used as a solvent). For this purpose, hydrolysis of the pentoses can easily be done at 1,000 lb. per square inch pressure, since most of the equipment is already available. Using super-pressure steam in this way gives results much superior to the ordinary methods of hydrolysing pentosans, such as are obtained from straw at about 50 lb. per square inch pressure.

We have arrived, therefore, at the stage when wood can be used as the raw material for the very large bulk production of sugars, which can be fermented to ethyl alcohol by yeast. The manufacture of sugars from wood has long been one of the primary dreams of the inventor. Methods for carrying it out have been known for over a century, and a considerable number of commercial plants have been operated; again, however, with disastrous financial results, since alcohol can be made much more cheaply from starch obtained from potatoes, various cereals, and other vegetable products. Two commercial plants for obtaining sugar from wood are now operating in Germany, heavily subsidised, however, from the public funds. The general principles involved in preparing alcohol and sugar from wood are to heat the wood under pressure with dilute sulphuric or hydrochloric acid to hydrolyse the celluloses and hemi-celluloses, and to a partial extent the ligno-celluloses, with the formation of mixed sugars; neutralise with lime, filter, ferment the sugar solution with yeast, and concentrate the dilute alcohol in column stills. The only trouble is the extremely high price of the finished product, a disadvantage shared by the products of other complicated chemical processes, such as the liquid fuels obtained by hydrogenation of coal and lignite, and the Fischer-Tropsch synthetic liquid fuel. As parallel cases, tea, coffee, bananas and pineapples could be grown in Great Britain, but not on a commercial basis.

The bulk production of sugars from wood as a by-product hitherto thrown away in the "Masonite," or any other, process, itself already on a commercial footing, is an entirely different matter, and constitutes a notable advance. It offers the possibility, for instance, that a large proportion of the world's vast output of waste wood, and of products such as branches, twigs, and roots, might be utilised as raw material for the joint production of plastic wood products and of sugars. The latter could also be utilised as food for animals and for the production of alcohol. The alcohol, in turn, might find a use in various organic synthesis processes; although, unfortunately, it makes only a low-grade motor fuel, high in oxygen content, even when blended with petroleum and the products of carbonisation and hydrogenation processes. Another new development is to carbonise the exploded wood fibres at 752 deg. to 842 deg. F. for six hours, giving an extremely dense carbon of high specific gravity, which is then "activated" at 1,472 deg. to 1,832 deg. F. for a further two to four hours, using a mixture of steam and waste combustion gas. The product would seem to be equal in quality to the activated carbon obtained from coconut shells, and other nut shells, but details of the process are lacking. An experimental plant for the production of activated carbon from Masonite fibres is illustrated in Fig. 8, on this page. The fibres are not sufficiently flexible for general use in papermaking in competition with the soda, sulphite, and sulphate pulp processes. Disruption of wood into its constituent fibres by the "explosive" action of steam has been known in the United States since about 1858, but it was not until 1925 that the work of W. H. Mason made the principle commercially applicable.

The Tay Ferries.—The Dundee Harbour Trustees recently decided to increase the fares and rates on the Tay Ferries as soon as permission to do so had been obtained from the Ministry of Transport. Passenger fares will be increased by ½d., season tickets by 10 per cent., motor cars by 6d., and goods-traffic rates by 10 per cent.

DEVELOPMENTS IN WOOD TECHNOLOGY.

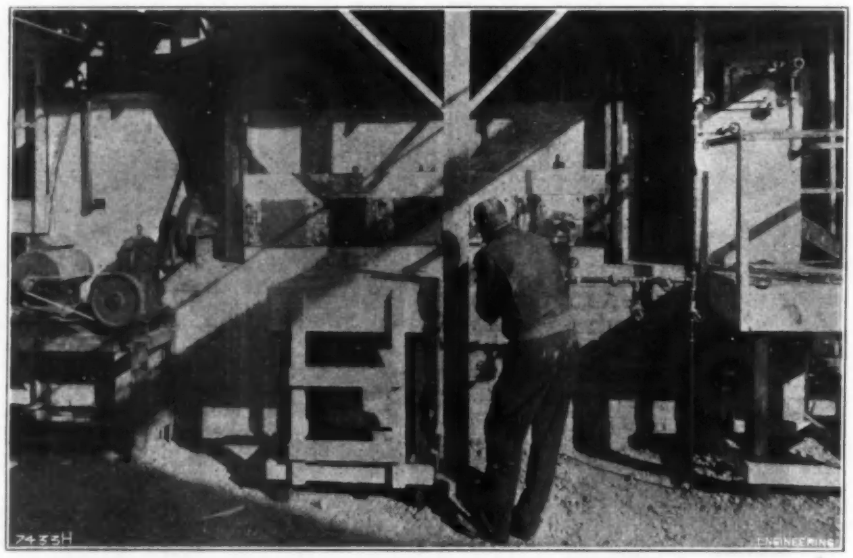


Fig. 8. Plant for Making Activated Carbon.

TRANSFORMERS FOR ELECTRIC FURNACES.

Electric-arc and electric-resistance furnaces generally have to be used in conjunction with transformer equipment, in order that the supply voltage may be reduced to a suitable value and varied between certain limits. The successful operation of such furnaces also depends on the provision in the transformer of certain special characteristics, and these must be combined with the robust construction necessary to withstand the very severe duty that is common. This statement may be illustrated by pointing out that the arc furnace is most widely employed for melting steel and maintaining it at a high temperature during the refining and alloying processes. It employs graphite or carbon electrodes, which are contained in a chamber lined with refractory material, the heat required being generated by arcs formed between these electrodes and the furnace charge. In most cases the charge is cold at the commencement of the cycle of operations and requires a maximum energy input at the higher values of the voltage available to bring it to the molten condition. During this part of the duty cycle, which lasts from 1½ hours to 2 hours, frequent and heavy overload conditions, amounting at times to short-circuit across the transformer secondary windings, are encountered. As the cycle proceeds the heat receptivity of the charge and the energy required diminish and the subsequent refining, when carried out, only necessitates a comparatively small input at a reduced voltage.

In view of the severe operating conditions during the melting period, high reactance may have to be incorporated in the furnace circuit. This may have to be of as high a value as 50 per cent. in order to limit the peaks on the supply system. Since it may be impossible to incorporate sufficient inherent reaction in the transformer and its connections for this purpose, it may be necessary to provide additional reactance in the form of a reactor mounted in the transformer tank or installed as a separate unit. This reactor is usually connected in the furnace circuit, so that it can be switched out of circuit at a certain point in the duty cycle, usually at the termination of the melting period.

It is important that the operator should be able to maintain close control of the energy input, since any heat generated in excess of that which can be absorbed by the charge is reflected to the furnace lining, especially to that of the furnace roof, and leads to rapid deterioration. The frequent renewal of the furnace lining is obviously expensive, and involves not only the actual cost, but loss of output. The control of energy to the furnaces is effected by adjusting the length of the arc and by altering the voltage tappings on the transformer. Owing to the high heat contents of the furnace and the charge, momentary interruption of the energy supply is unimportant, and, therefore, it is usually unnecessary to incur the expense of providing for the changing of the transformer tappings on load. The range of secondary voltage required is considerable, being, for example, 60 per cent. in the case of a steel-melting furnace, and 30 per cent. in the case of a carbide furnace.

Resistance furnaces, on the other hand, are used for processes requiring a constant temperature or a slow temperature cycle, such as heat treatment and annealing. The heat is generated by resistance units of special alloy or, in certain cases, by the resistance of the charge itself. It follows that constant current is required, not constant kilovolt amperes, and that in many cases only infrequent voltage adjustment is necessary. This is effected by tapping boards or by a standard type of manually-operated off-circuit tapping switch. Some types of large resistance furnace have a number of heat zones, the units in each zone being separately supplied by low-voltage transformers, which, in turn, are supplied from a main step-down unit taking a high-voltage supply from the mains. The relative temperatures of the various zones can be adjusted by tapping links on the individual low-voltage transformers, while the temperature cycle of the furnace is controlled by primary tappings on the transformer in much the same way as for arc furnaces.

While furnace transformers are, in general, built to comply with the current British Standard specification, the operating conditions, as will have been gathered, are very arduous and only the best mechanical construction for the windings, tap changers and terminals is admissible. How these conditions are met may be illustrated by referring to the special transformers which are constructed for electric-furnace supply purposes by Messrs. The British Thomson-Houston Company, Limited, Rugby. The core insulation of these transformers complies with the requirements of the British Standard specification for Class B insulation. The laminations are coated with a special flash enamel, which is applied at a high temperature, while, as an additional precaution, sheet asbestos is inserted at 1-in. intervals when the larger cores are built up. The core-bolt insulation consists of asbestos and synthetic resin, which is moulded on under high pressure and temperature. Vertical ventilating ducts are provided by H-section spacers, which are welded to adjacent core plates, and horizontal ducts by means of slots in the laminations. These slots are located between and in line with the core-bolt holes.

Furnace transformers can be built for any primary voltage. The primary windings are generally of the same construction as those on distribution transformers of a similar rating, and the heavy current secondary windings consist of a number of coils connected in parallel, each coil having only a few turns of adequate cross section. These coils are made up of a large number of strands in parallel to ensure satisfactory current distribution. Either the concentric or the interleaved arrangement of windings may be adopted. The former is illustrated in Fig. 3, on page 510, which shows a 2,460-kVA, 20,000/180-79-volt transformer, and the latter, in Fig. 4, on the same page, which shows a 8,400-kVA, 6,600/246-84-volt unit. Both transformers have been specially designed for furnace work. In both cases great care has been taken by suitable disposition of the windings to ensure good electromagnetic balance under all operating conditions and

TRANSFORMERS FOR ELECTRIC FURNACES.

MESSRS. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, RUGBY.

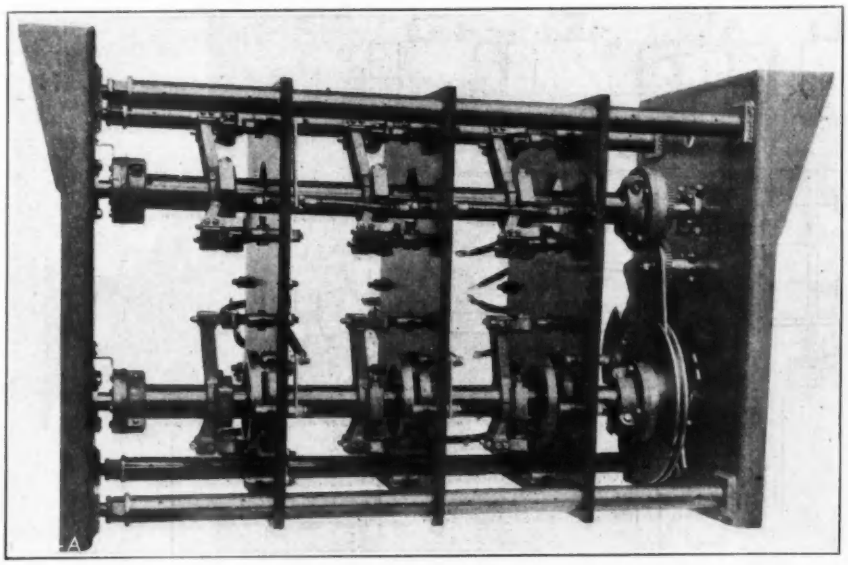


FIG. 1. OFF-CIRCUIT TAP AND CONNECTION CHANGE SWITCH.

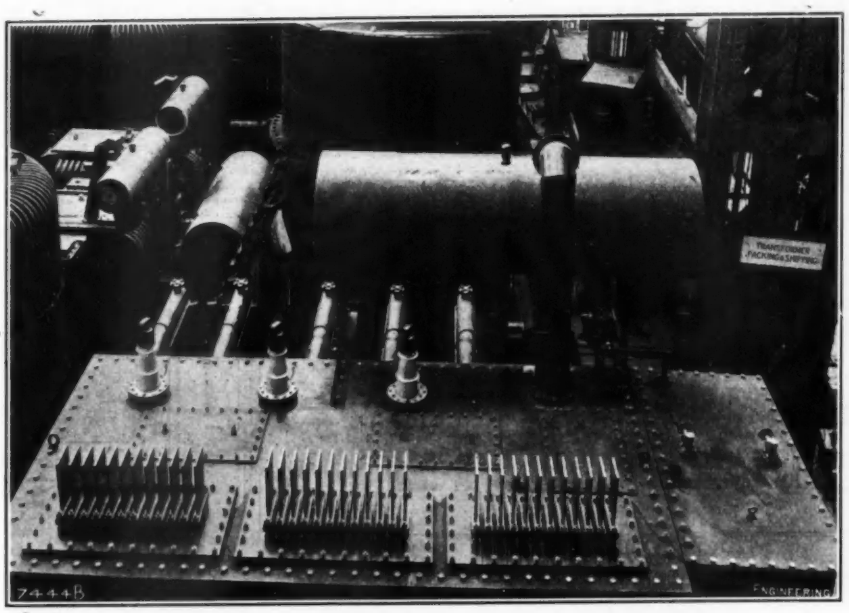


FIG. 2. TANK COVER OF 7,500-KVA TRANSFORMER.

also to brace and anchor the conductors to withstand the heavy short-circuit forces.

As stated previously, constant current output over a voltage range up to 60 per cent. is a usual requirement. In such cases the primary winding is tapped and arranged for delta-star connections, all the tappings and phase ends being brought up to off-circuit tapping and change connection equipment arranged for manual control, or, more usually, for remote control. The equipment is always interlocked with the primary circuit breaker, so that the latter must be opened before the former can be moved. It should be noted that the normal type of off-circuit tapping switch, such as is saisfactory on power transformers, is quite unsuitable for this duty, which, on account of very infrequent operation, requires much more robust equipment. The off-circuit tap-changing equipment provided on the British Thomson-Houston furnace transformers is, in effect, "on load" gear specially adapted to furnace operating conditions. A type of tapping and change connection switch which is suitable for fitting to the larger sizes of furnace transformers is illustrated in Fig. 1, above; it can be used on supply pressures up to 33 kV. In cases where constant kilovolt-ampere output or on-load tap changing is essential, it is obviously impossible to use the delta-star arrangement of primary windings. This increases the size and cost of the transformer approximately in the ratio of the maximum to minimum secondary voltage.

For most types of arc furnaces, high reactance is required to stabilise the arc and to reduce peak loads on the supply system during the melting period. It is usual for reactors to be provided in series with the primary to supplement the inherent reactance of the transformer. The amount of this reactance is governed not only by the furnace characteristics, but by economic conditions, such as maximum-demand charges, system voltage and regulation under which the electricity supply is obtained. In practice, the total reactance required for individual installations may vary from 20 per cent. to 50 per cent. Where the delta-star arrangement of primary windings is employed, the inherent transformer reactance is often sufficient if the primary windings are star-connected, and provision can be made for the insertion of this supplementary reactance only when the higher secondary voltages are in use, that is, during the melting period. To ensure flexibility, the reactor is usually provided with tappings to give alternative values of reactance.

Secondary currents may be required up to a very large value and when these currents exceed 2,500 amperes delta-connected secondary windings are preferable so as to obtain the minimum winding current and the maximum number of secondary turns per phase. Owing to the heavy currents involved, the secondary terminals of furnace transformers almost always consist of copper bars brought out through non-magnetic inserts in the tank side or cover and these bars are interleaved to reduce the reactive drop of stray losses in the base, the secondary interphase connections being made at a point as close to the furnace electrodes as possible.

The selection of the best method of cooling is also a matter for careful consideration in each individual case. For small resistance-type furnaces, air-cooled dry transformers are probably the best. Although they are more expensive than oil-immersed units, they have lower fire hazards and can, therefore, be located close enough to the furnace to enable the length of the secondary leads to be reduced. The substitution of transformers filled with Permitol, a non-flammable liquid dielectric, for oil-filled units, may be worth consideration in such cases. Oil-immersed self-cooled units are usually employed for the larger resistance-furnace transformers and for all arc furnaces up to about 5,000 kVA, although space limitations may necessitate forced cooling at lower ratings than this. For units above 5,000 kVA, forced oil circulation with water cooling is usually most satisfactory. Cooling water has to be provided for the furnace and is, therefore, available. For this type of cooling, the British Thomson-Houston Company employ a glandless oil pump in which the driving motor is immersed in the oil and circulates it from the top of the transformer tank through a heat exchanger, in which the heat is transferred to the cooling water, and back to the bottom of the tank. This cooling equipment can be mounted on the transformer tank.

Furnace transformers frequently have to operate under very dirty conditions, and it is therefore advisable to avoid bare high-voltage connections where possible and to bring the primary supply through cable boxes into the tank. The use of oil conservators with magnetic oil gauges is recommended, although it should be noted that they add appreciably to the first cost of large heavy-current units because they necessitate oil-tight glands on the secondary copper bar terminals, as illustrated in Fig. 2. Where conservators are provided, Bucholz protective devices can be fitted to give protection against internal faults. A thermometer with maximum reading pointer and alarm contacts is desirable on the larger units.

DIRECT-REVERSING MARINE DIESEL ENGINE.

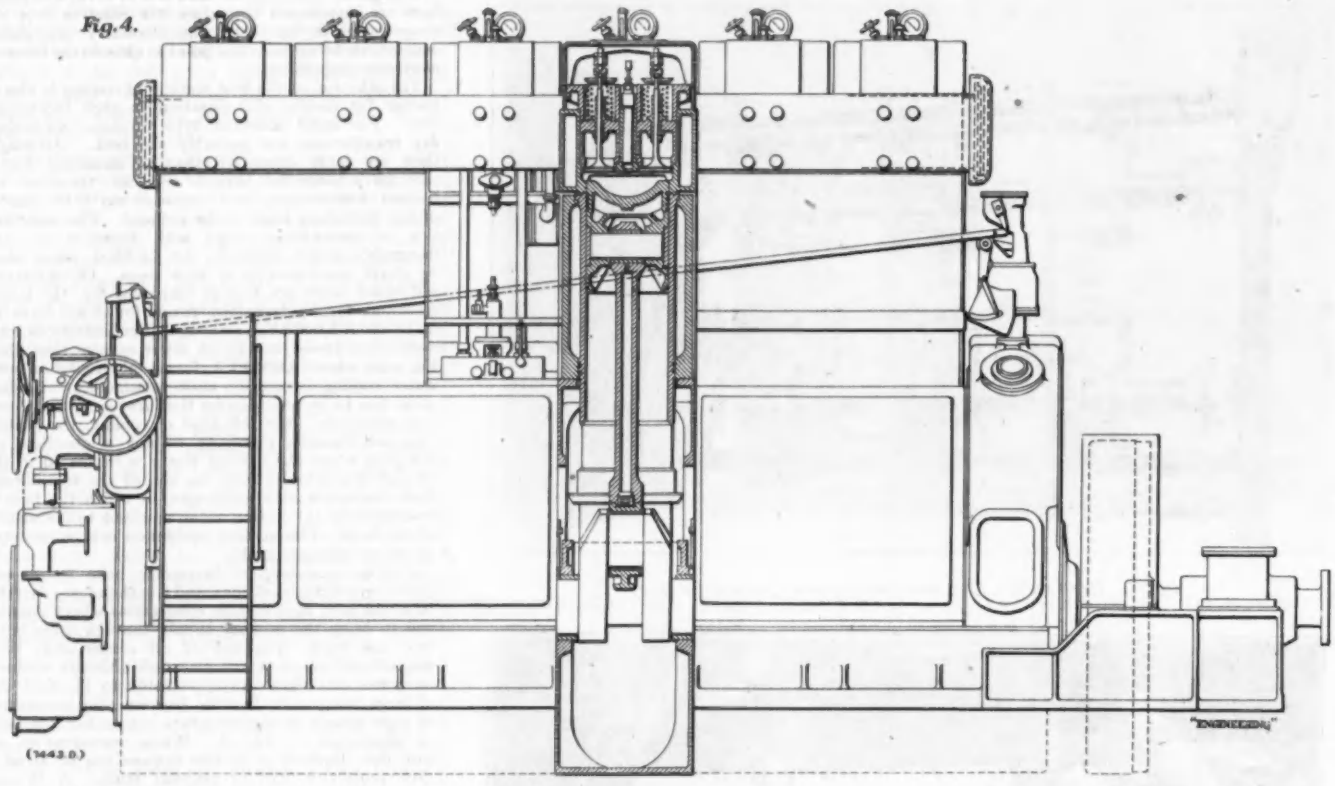
BEFORE describing the new direct-reversing, four-stroke cycle marine Diesel engine manufactured by Messrs. Mirrlees, Bickerton and Day, Limited, Hazel Grove, near Stockport, and illustrated in Figs. 1 to 7, on Plate XXXVI, and on pages 506 and 507, it is desirable to comment on the conditions governing the design. As is well known, the firm has for a number of years produced marine Diesel engines as well as engines for industrial purposes, and the marine engines have been of the four-stroke cycle type and have ranged in output from 300 brake horse-power to 800 brake horse-power. The good results obtained from the well-known "HF type" industrial airless-injection engine, which has been built with both normal induction and supercharging by Büchi turbo-blowers and designed to run at speeds of 375 r.p.m. and 428 r.p.m., decided Messrs. Mirrlees, Bickerton and Day to employ the cylinder heads, valve gear and running gear of this type combined with the bilge pump, circulating-water pump and compressor end of their previous marine engines, to form the new marine engine.

The adoption of the industrial type cylinder heads has involved a radical change in the firm's system of reversal, as follows: In the former marine engines a single cam was employed for each valve, reversal being effected by using the inlet valve as the exhaust valve. This method, the performance of which is quite satisfactory, had the disadvantage that supercharging by turbo-blower could not be arranged. Turbo-blower supercharging, in the industrial engines, had been found to result in improved economy, reduction in weight and space, and an increase in the range of power which can be covered by a series of engines of given cylinder bore and stroke. The new marine engine can operate with the turbo-blower, since there are two cams per valve, *i.e.*, one for ahead running and one for astern running, each valve, of course, maintaining a single function, inlet or exhaust as the case may be, in either direction of rotation. It is proposed to manufacture the new marine engine with 6 cylinders, 7 cylinders or 8 cylinders. The power per cylinder is 90 brake horse-power at 300 r.p.m., with normal induction, and 135 brake horse-power at the same speed with turbo-blower supercharging. At lower speeds proportional powers will be developed; thus, when supercharged,

DIRECT-REVERSING MARINE DIESEL ENGINE.

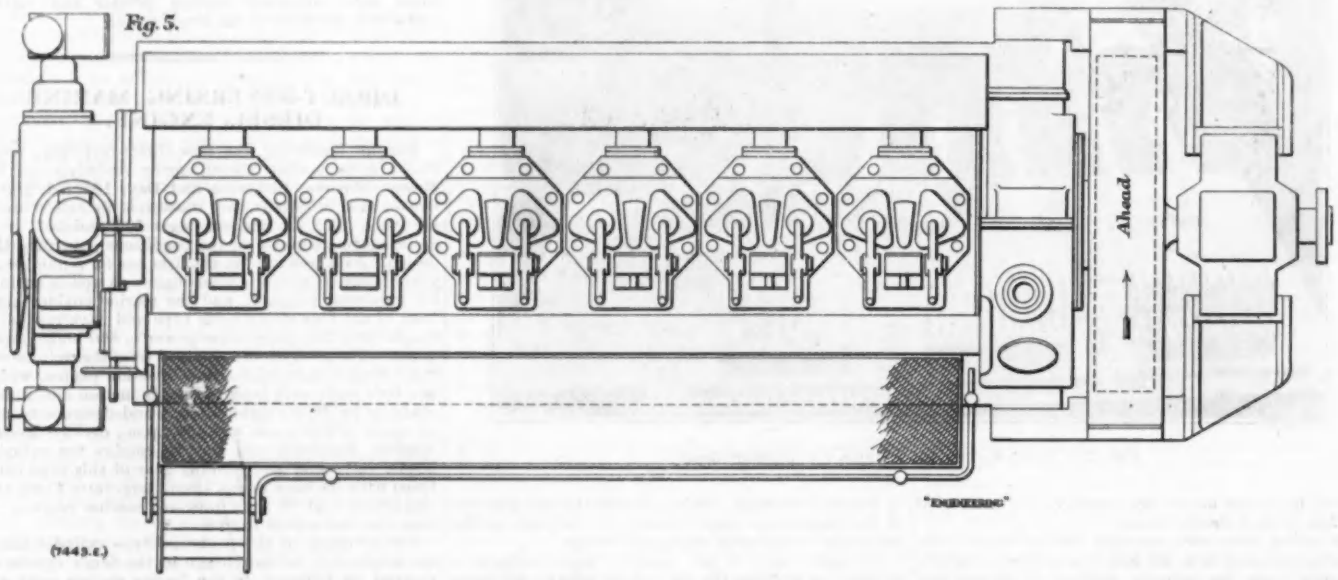
MESSRS. MIRRLEES, BICKERTON AND DAY, LIMITED, STOCKPORT.

Fig. 4.



(7443.b)

Fig. 5.



(7443.c)

the engines will cover a range of powers from 400 brake horse-power for the 6-cylinder engine to 1,080 brake horse-power for the 8-cylinder engine at 250 r.p.m.

The first engine constructed, which we now illustrate, is of the 6-cylinder size, each cylinder having a bore of 13½ in. and a stroke of 21 in., the total output being 540 brake horse-power at 300 r.p.m., with normal induction. Its general arrangement will be clear from the external view, Fig. 1, on Plate XXXVI, and from the drawings, Figs. 4 and 5, on this page, but it may be pointed out that no light casing covering the cylinders on the fuel-pump side is shown in Fig. 1, marine practice generally preferring open gears. It can, however, be fitted when desired and is shown in place on four of the cylinders in Fig. 4. A further difference between these illustrations may be mentioned. Nothing is shown below the bedplate flange in Fig. 1, whereas it will be evident from Fig. 4 that the crankpit sump extends below the flange level, the actual distance between the two levels being 10¼ in. The total height from the flange level to the tops of the circulating-water outlet thermometers is 9 ft. 7⅛ in., the overall length from the shaft flange to the control wheel being about 17 ft. 10 in. and the width over the bedplate flange being 4 ft. 10½ in. The extreme width over the flywheel casing at the after end is 5 ft. 10½ in., and that over the pumps at the forward end is 5 ft. 8 in. The total weight is 26½ tons, and the engine is distinguished as "mark HFR.6." The centre of gravity is low, being 3 ft. 1 in. above the flange level; longitudinally it is 2 ft. 9 in. forward of the after cylinder centre line.

The engine bedplate is a single casting with two extensions at the after end carrying the Michell thrust block, seen to the right of Figs. 4 and 5, and the flywheel guard. The flywheel is 4 ft. 6 in. in diameter by 10 in. wide, and the direction of rotation is clockwise when the engine is viewed from the thrust block. The main bearings consist of white-metal lined steel shells. The crankshaft is a single forging of 34 to 38 tons tensile Siemens-Martin steel, and is heat treated. Its diameter is large to minimise torsional vibration at critical speeds. The crankcase is a single well-ribbed casting with large access doors. Incidentally, the piston and connecting-rod assembly can be withdrawn either through these openings or upwards after removal of the cylinder head. The cylinders are individual castings and are bolted to the top of the crankcase through deep flanges as seen in Fig. 1. Accidental fracture of a cylinder, therefore, only involves replacement of one cylinder, instead of a complete monobloc casting. The liners are of the wet type, held in place by the cylinder heads and made watertight in the cylinder by rubber rings at the bottom. The heads are octagonal in plan and are attached to the cylinders by eight through bolts. As shown in Fig. 4, the inlet and exhaust valves are housed in removable cages held down by separate sleeves with triangular flanges. The air-inlet and exhaust passages are cast in the head on opposite sides, an arrangement giving a simple and accessible construction for the inlet and

DIRECT-REVERSING DIESEL MARINE ENGINE.

CONSTRUCTED BY MESSRS. MIRRLEES, BICKERTON AND DAY, LIMITED, HAZEL GROVE, STOCKPORT.

(For Description, see Page 505.)

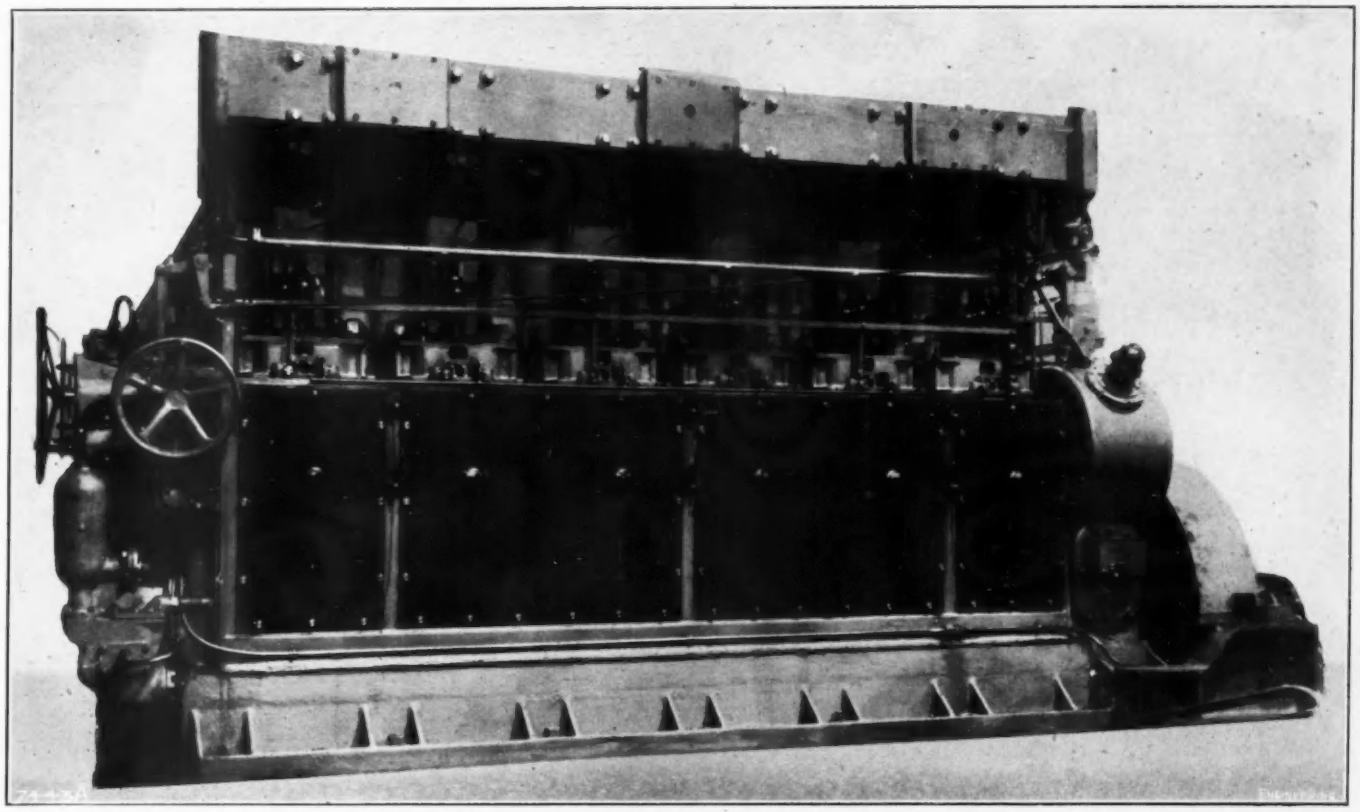


FIG. 1. SIX-CYLINDER ENGINE WITH MICHELL THRUST BLOCK.

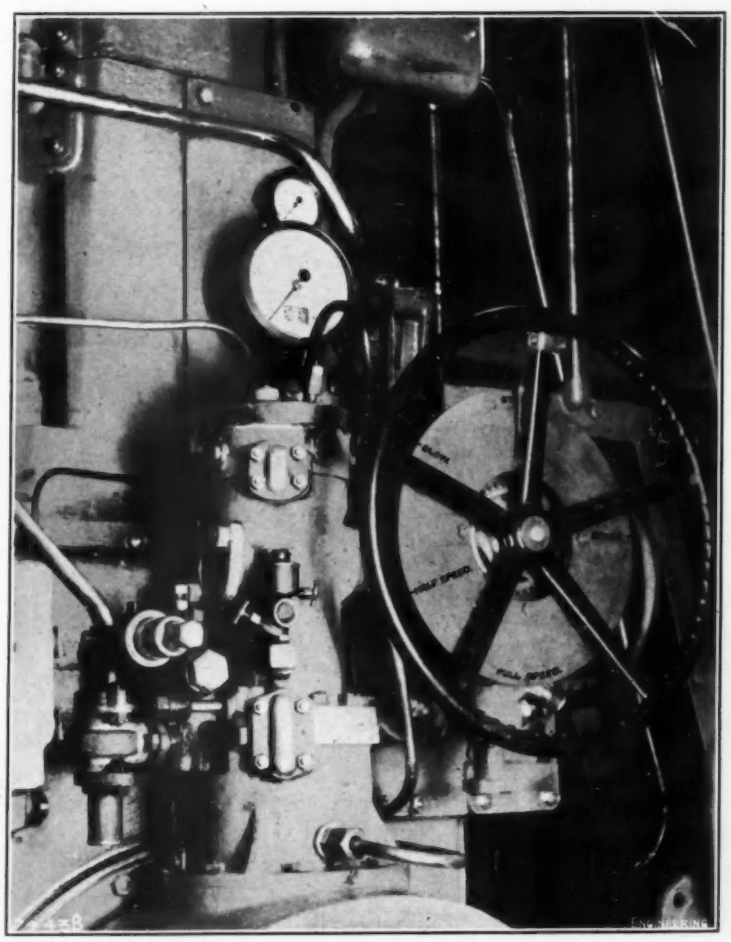


FIG. 2. AIR COMPRESSOR AND CONTROL WHEEL.

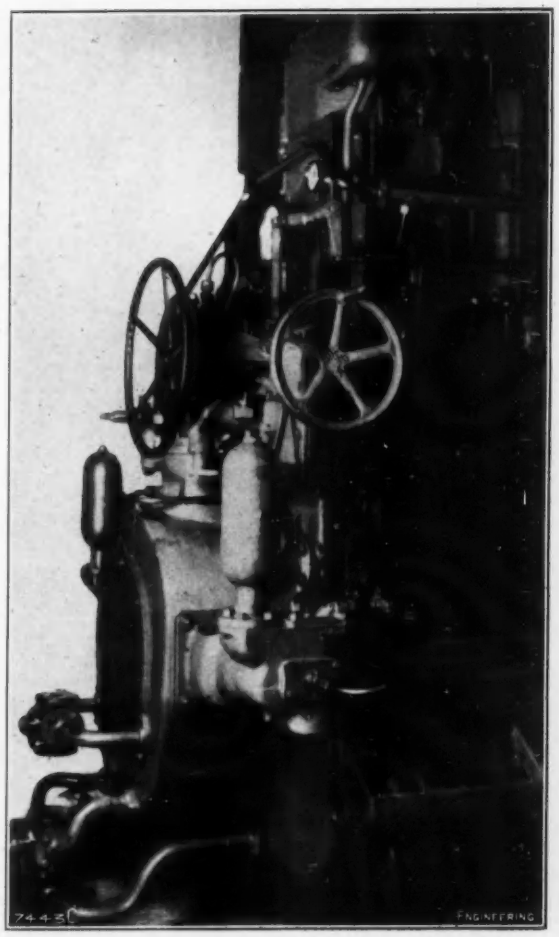


FIG. 3. PUMP ASSEMBLY AND REVERSING WHEEL.

(To face page 506.)

UNIV. OF MICH.

DIRECT-REVERSING MARINE DIESEL ENGINE.

MESSRS. MIRRLEES, BICKERTON AND DAY, LIMITED, STOCKPORT.

Fig. 6.

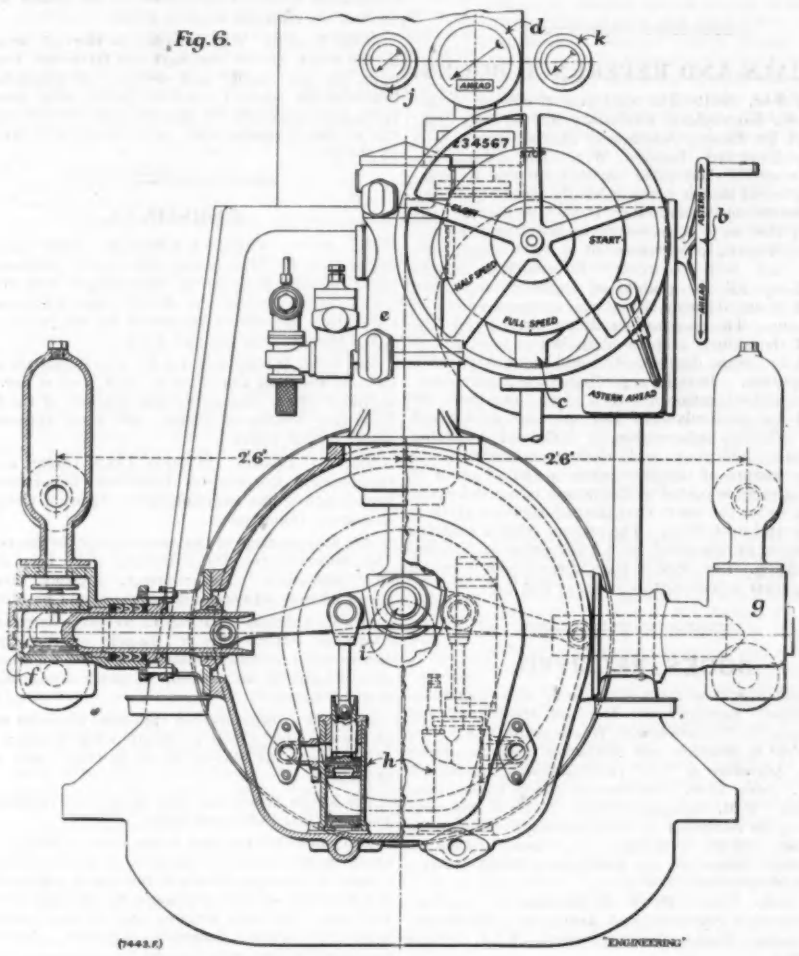
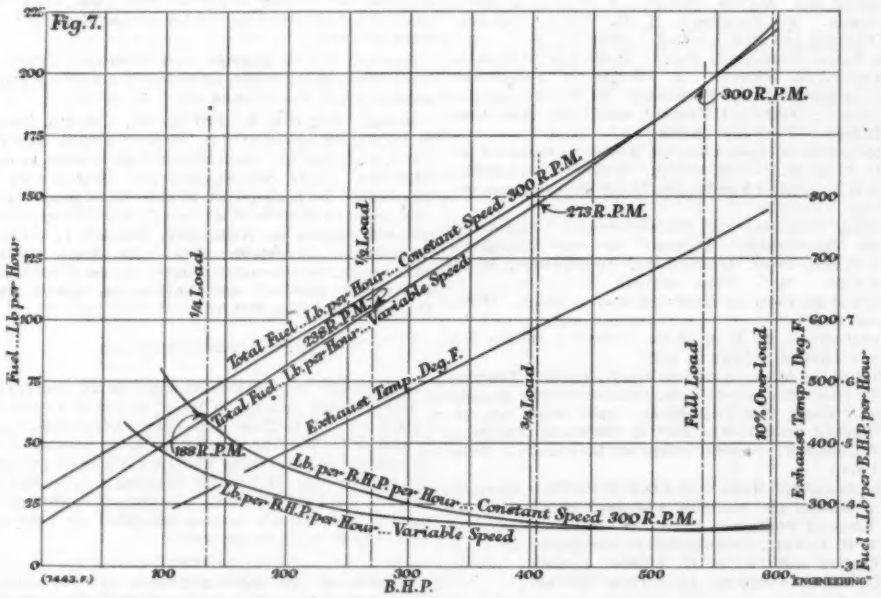


Fig. 7.



exhaust manifolds; the former run along the front of the engine and the latter along the back.

The fuel-injection nozzle is in the centre of the head. The heads are water-cooled, the water passages between the cylinder jackets and heads being made by two external connections on each cylinder. The cooling water is discharged into the head at the hottest part of the nozzle housing. The pistons have concave tops and are fitted with four pressure rings and one scraper ring. An internal plate is fitted above the gudgeon pin to prevent splashing of oil on the hot piston top. The gudgeon pin is of the floating type with end retaining covers and is of Nitralloy hardened steel. The connecting rod small-end bearing is a bronze bush, and the big-end bearing is formed of cast-steel housings, which are of the marine type and white-metal lined. The housings are attached to the palm of the connecting rod by four bolts. The valve gear is of the normal push-rod type, actuated from a single camshaft running through the crankcase and driven by machine-cut spur gears from the after end of the crankshaft. The fuel pumps are situated between the tappet rods, as will be clear from Fig. 1, the delivery pipes being thus all of equal length. The pumps are of Bosch type and are, of course, driven from the camshaft, which also transmits motion through bevel gears, to a four-weight centrifugal governor. The fuel pumps are controlled from the governor by means of rod and lever mechanism. A separate adjustment of the delivery of fuel to each cylinder can be made at each pump.

The controls are all arranged at the forward end of the engine and are shown in the two external views of this end given in Figs. 2 and 3, Plate XXXVI, and in the line drawing, Fig. 6, on this page. The large handwheel towards the top of this figure controls starting, stopping and engine speed, the smaller wheel *b* at right angles to it effecting reversal. Ahead and astern cams are mounted on the camshaft for each valve push rod and a swinging arm with double rollers brings the correct roller for ahead or astern running into position when the reversing wheel is manipulated. The large handwheel is backed by an index plate graduated as shown in Fig. 6. These graduations, it will be recognised, indicate that the wheel controls the starting air and the fuel rate. Both wheels are interlocked in such a way that the reversing wheel can only be turned when the control wheel is in the "stop" position, and the control cannot be moved from this position unless the reversing wheel is fully "ahead" or "astern." The starting air supplied to the various cylinders is controlled by a rotary distributor of the ported-sleeve type, which is set by the movement of the reversing wheel. The actual supply, however, is regulated by the control wheel, movement of which from the "stop" position puts starting air on all the cylinders by opening a master valve indicated by *c* in Fig. 6. When the engine is turning the starting air is cut off and fuel is injected into all the cylinders.

After this, appropriate movement of the control wheel regulates the quantity of fuel supplied. Moreover, the wheel is connected to the governor by a cable, so that the load on the governor spring is varied and the setting is thus modified to give any required rate from idling speed to full speed. This arrangement enables the engine to be governor-controlled throughout the full range of speeds, which is a distinct advantage for marine service, as it practically prevents racing should the propeller become unsubmerged. Thus, should pitching take place when the engine is running at, say, half speed, the rotational speed is increased by some 20 r.p.m. only. Further, with the engine under the control of the governor at the idling rate, the minimum speed obtainable is lower than when idling is obtained by controlling the fuel only. The cable between the control wheel and the governor is fitted with a turnbuckle adjusting device, by means of which it is possible to obtain a temporary over-speed. A tachometer *d* is mounted above the control wheel, its dial being provided with an indicator showing the direction of engine rotation. In Fig. 6, a revolution counter is seen below the tachometer, but this fitting is not provided in the arrangement shown in Fig. 2. The tachometer is driven from the camshaft, while a second tachometer, situated on the bridge of the vessel, is electrically-operated from the small generator seen on the gearcase to the right of Fig. 1. The function of this second instrument will be obvious when it is realised that the engine controls are arranged so that starting, stopping or speed variation can be effected either from the bridge or from the engine room as desired.

The arrangement of the auxiliaries at the forward end of the engine may now be referred to. These auxiliaries are shown in Fig. 6 and comprise an air compressor *e*, a circulating-water pump *f*, a bilge pump *g*, and two lubricating-oil pumps *h*. All five are driven, either directly or indirectly, from the crank *i*, which is geared to the forward end of the crankshaft. The air compressor, seen also to the left of the control wheel in Fig. 2, is of the two-stage type with a water-cooled intercooler between the stages. The water supply is taken from the engine jacket supply and after leaving the compressor is led to the Michell thrust block, thence to the suction side of the bilge pump, the object of the latter connection being to prevent the bilge pump becoming dry, cup leather packing being fitted. The compressor is automatically controlled by the valve seen to the left of it in both Figs. 2 and 6. It is cut out when the pressure in the air bottles reaches 350 lb. per square inch, and begins to deliver again when the pressure falls to 250 lb. per square inch. There are two air bottles, each of 22 cub. ft. capacity, this capacity providing sufficient air for 30 manœuvring operations. A small bottle, of 5 cub. ft. capacity, which can thus be very rapidly charged, is provided for starting the engine in an emergency should the main bottles have become empty. The pressure in the bottles is indicated on the gauge *j* in Fig. 6.

The circulating pump and bilge pump are single-acting ram pumps and are identical in design. The

ram is 3½ in. in diameter by 5½ in. stroke. They are interconnected, so that the bilge pump can take over the duty of the circulating-water pump when necessary. The circulating water passes first from the water manifolds to the cylinders, thence to the cylinder heads, and finally to the jacket of the exhaust manifold. The water outlet on each head is provided with a regulating valve and a thermometer. These fittings are seen in Fig. 4, the dial gauges near them being individual exhaust thermometers. Special care has been taken with the joints in the circulating-water system, so that no water can leak into the cylinders; no external leakage can get into the crankcase. The lubricating-oil pumps are situated inside the forward gearcase and so are not visible in Fig. 3, though the pipe connections at the bottom left-hand corner of this figure are part of the system, being change-over apparatus connecting one pump with the other. The construction of the pumps will be clear from Fig. 6. One of them draws the oil from the bedplate sump and delivers it to a tank situated on a convenient bulkhead, while the other draws from the tank and delivers it under pressure to the engine. The cross-connections enable either pump to be used for either duty, and, should either pump break down, the other can lubricate the engine on the wet-sump system by drawing the oil from the bed and delivering it under pressure to the bearings. The oil pressure is indicated on gauge *k* in Fig. 6. A spring-loaded relief valve, with a by-pass for excess oil, is fitted to the delivery system for adjustment of the pressure. The oil, before delivery to the engine, is passed through a tubular cooler in the water inlet manifold and through a double filter, in which one element can be cleaned while the other is in service. The main bearings, connecting-rod bearings and camshaft bearings are pressure-lubricated.

As regards the fuel-oil supply, the engine will run on any normal Diesel fuel. Duplicate fuel filters of the Lolos type are provided. Provision is made for the fitting of a fuel heater on the engine exhaust pipe should oil of high viscosity have to be used. The fuel-injection system incorporates a stop to limit the amount of fuel supplied per stroke, so that the maximum consumption can be controlled. As will be evident from Fig. 4, the air-inlet manifold is provided with a filter at each end.

The new engine has shown a satisfactory performance under a comprehensive series of tests. The results from some of these tests have been plotted in Fig. 7, on page 507. The fuel consumptions in lb. per brake horse-power per hour were as follows:—

Load.	At 300 r.p.m.	At Varying Speed.
¼	0·525	0·450
½	0·415	0·382
¾	0·370	0·363
Full	0·360	0·360
10 per cent. overload	0·370	0·365

In considering the fuel consumption at full load it should be remembered that the engine was driving its own circulating-water pumps, bilge pumps and starting-air compressor. These auxiliaries are not infrequently independently driven on shipboard, so that the consumption of 0·36 lb. per brake horse-power per hour may be justly claimed by the makers to be a very low one for an engine of the size concerned. The consumption figures for varying speeds are based on the so-called propeller law. The difference between the two sets of fuel figures is, perhaps, more clearly seen in Fig. 7; thus, below the full-load point less power is needed to propel the vessel, and, in consequence, the engine revolutions may be decreased with a consequent lower total fuel consumption and consumption per brake horse-power hour. The variable-speed figures show that, at all loads down to about three-eighths full load, the consumption was below 0·4 lb. per brake horse-power hour.

The engine was tested for full output up to 330 r.p.m., and an idling test was made for a period of half-an-hour at 85 r.p.m., the total fuel consumption at this rate working out to only 10 lb. per hour. Moreover, when the engine was warm it was possible to run it at an idling speed of as low as 75 r.p.m. without signs of misfiring on any cylinder, the engine being under control of the governor the whole time. The results generally were the same whether the engine was running in the ahead or astern direction. With the fuel stop referred to above in operation, a torque curve was constructed which showed that the engine would "pull" proportional power at any speed. Tests made on the efficiency of the air compressor showed that it would charge the air-bottles from half pressure to full pressure in half-an-hour. The small auxiliary bottle could, of course, be charged in much less time. A series of manœuvring trials was made to ascertain the actual starting capacity of the air bottles. Commencing with both the 22-cub. ft. bottles fully charged to a pressure of 350 lb. per square inch, 14 manœuvring operations were made as quickly as possible until the pressure in one of the bottles had fallen to 130 lb. per square inch. The time required for a full manœuvre, *i.e.*, from "full speed ahead" to "full speed astern," was 8 seconds on the test bed, and that required from "slow ahead" to "slow astern" was 5 seconds.

ANNUALS AND REFERENCE BOOKS.

Who's Who, 1941.—The 93rd annual edition of this well-known biographical dictionary has recently been published by Messrs. Adam and Charles Black, 4, 5 and 6, Soho-square, London, W.1. The volume has so firmly established itself throughout the English-speaking world that it appears hardly necessary to say much concerning its contents. It may be pointed out, however, that as it is necessary to begin printing the work in August, occurrences of a later date have perforce not been recorded. Nevertheless, deaths reported up till the middle of October have been included in an obituary list at the commencement of the volume. The biographies follow precedent; the name of the subject is printed in heavy type and is followed by titles, degrees, etc., and present position or occupation. Details regarding birth, parentage, marriage and education are then given, and these are followed by particulars of the subject's subsequent career. Finally, information is furnished regarding recreations, addresses and club memberships. A valuable feature of the data given is that a proof of each biography is posted to the person concerned every year, in order to ensure that the information given is accurate and up to date. The present edition contains 3,488 pages, as compared with 3,532 pages in the previous edition. The price of the volume, which is bound in its familiar scarlet-cloth covers, is 65*s.* net.

BOOKS RECEIVED.

The River Great Ouse Catchment Board. Report on Flood Protection. London: Sir Murdoch MacDonald and Partners, 72, Victoria-street, Westminster, S.W.1.

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Volume 12, No. 1. *June*, 1940. Compiled by Agnes E. Glennie. London: H.M. Stationery Office. [Price 4*s.* 6*d.* net.]

Journal of the Institution of Civil Engineers. Volume 13. *Session* 1939-40. Volume 14. *Session* 1939-40. London: Offices of the Institution, Great George-street, Westminster, S.W.1.

Works Boiler Plant. By F. J. Matthews. London: Hutchinson's Scientific and Technical Publications, Paternoster House, Paternoster-row, E.C.4. [Price 10*s.* 6*d.*]

Classical and Modern Physics. A Descriptive Introduction. By Professor H. E. White. London: Chapman and Hall, Limited. [Price 21*s.* net.]

The Oxford Engineering Series. Relaxation Methods in Engineering Science. A Treatise on Approximate Computation. By Professor R. V. Southwell. London: Oxford University Press (Sir Humphrey Milford). [Price 17*s.* 6*d.* net.]

Bibliography of Spectrochemical Analysis. Compiled by D. M. Smith. Second edition. Euston-street, London, N.W.1: British Non-Ferrous Metals Research Association. [Price 3*s.*]

Railway Signalling and Communications. Installation and Maintenance. London: The Saint Margaret's Technical Press, Limited, 33, Tothill-street, Westminster, S.W.1. [Price 8*s.* net.]

Who's Who, 1941. London: A. and C. Black. [Price 65*s.* net.]

Transformers. By E. E. Wild. London: Blackie and Son, Limited. [Price 5*s.* net.]

The Practice of Arc Welding. By W. Heigh. London: Sir Isaac Pitman and Sons, Limited. [Price 5*s.* net.]

United States War Department. Port Series No. 16. (Revised, 1939.) *The Port of Baltimore, Maryland.* Washington: Superintendent of Documents. [Price 1 dol.]

The Analysis of Minerals and Ores of the Rarer Elements. A Manual for Analytical Chemists, Metallurgists and Advanced Students. By Dr. W. R. Schoeller and A. R. Powell. Second edition, rewritten. By D. A. Lambie and Dr. R. C. Wells. London: Charles Griffin and Company, Ltd. [Price 18*s.* net.]

The North American Motor-Car Industry.—It is stated in a recent issue of the monthly journal *Tin* that, in the 40 years 1900-1939, a total of 79 million motor vehicles were produced in the United States and Canada. In 1900, the output amounted to 4,192 vehicles, all of them passenger cars. In 1939, a total of 2,975,165 passenger cars and 757,553 lorries were produced.

TENDER.

We have received from the Department of Overseas Trade, 99-103, St. Michael's-road, Bournemouth, particulars of the undermentioned tender, the closing date of which is as stated. Details may be obtained on application to the Department at the above address, quoting the reference number given.

Motor Tractors. With reference to the call for tenders, by the South African Railways and Harbours, Johannesburg, for the supply and delivery of industrial-type, four-cylinder engined tractors, fitted with pneumatic tyres, noted on pages 468 and 488, *ante*, we now learn that the extended closing date is February 17, 1941. (T. 23,013/40.)

PERSONAL.

Mr. W. G. Smith, M.I.Mech.E., chief mechanical engineer to the Manchester Ship Canal Company, Ship Canal House, King-street, Manchester, will retire at the end of the current year after 45 years' service with the Company. He will be succeeded by Mr. T. A. Guest, A.M.I.Mech.E., his present deputy.

Mr. J. W. Wicks, A.M.I.A.E., who joined the London General Omnibus Company in 1930, and is now acting technical officer (omnibuses and coaches) of the London Passenger Transport Board, has been appointed an officer of the Board.

Mr. E. Deakin, hitherto chief traffic assistant, Huddersfield Corporation Transport Department, has been made traffic superintendent, Ipswich Corporation Transport Department.

The headquarters of the Association of Engineering and Shipbuilding Draughtsmen have been removed to "Mansefield," Market-street, Rugeley, Staffs, to which address all communications should be directed.

Mr. V. A. Perkins, P.A.S.I., recently chairman of the Northern Ireland Junior Branch of the Chartered Surveyors' Institution, has left Belfast to take up an appointment as an assessor in Hong Kong under the Colonial Office.

Mr. T. W. Jones has been appointed honorary secretary of the Chemical Club, Whitehall-court, London, S.W.1, in succession to Major F. J. Bullen, who has left London.

Sir Keith Price has been re-elected President of the British Wood-Pulp Association.

The goodwill, patents, trade mark "Koppers," and other similar assets of Messrs. Koppers Coke Oven Company, Limited, Sheffield, have been taken over from the Receiver of that Company by Messrs. Woodall-Duckham Vertical Retort and Oven Construction Company (1920), Limited, Uplands, Epsom-road, Guildford, Surrey, who are now in a position to deal with inquiries for various types of plant and apparatus formerly supplied in this country by the Koppers Coke Oven Company.

Messrs. W. C. Holmes and Company, Limited, Turnbridge, Huddersfield, advise us that their telephone number is now Huddersfield 5281.

Messrs. Delco-Remy and Hyatt, Limited, inform us that their offices at 111, Grosvenor-road, London, S.W.1, including the administrative, accounting, general sales and supply departments, are being moved to Dunstable. In consequence of this, these departments were closed for business at noon on Tuesday, December 24, and will re-open on Wednesday, January 1, 1941, at Church-street, Dunstable, Beds. The firm's electric-motor sales, electric-motor repairs, service departments and works, however, will continue to operate from 111, Grosvenor-road, S.W.1.

Association of Supervising Electrical Engineers.—Owing to the inability of Mr. F. S. Naylor to give his lecture on "War-Time Temporary Expedients," and in view of the existing circumstances, the meeting of the Association of Supervising Electrical Engineers arranged for January 21, 1941, at the Lighting Service Bureau, London, has been cancelled. An announcement regarding the Association's meeting scheduled for February, 1941, will be made in due course.

Economies on Road-Building in Scotland.—Savings are to be effected on several road-construction schemes in Scotland. A reduction of 24,000*l.* has been made in the estimates of the cost of the Carse of Gowrie improvement scheme; footpaths and cycle tracks are to be eliminated at some points. Moreover, there is to be a saving of 2,209*l.* on the Cupar-Angus scheme, while, in the Dunblane area, several major schemes have been cancelled for the time being, with the exception of two new bridges. The Aberdeen County Road Board has decided to reduce its estimates on road expenditure for 1940-41 by approximately one-third.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—The majority of the staple trades have returned nearly to normal working, and steelmakers are maintaining outputs at a high level. Though the Government services are taking a great proportion of Sheffield's supply of semi-finished and finished products, an increasing volume of ordinary commercial business continues to be done. Railway rolling stock is in better demand, both on home and overseas account; British railways are taking supplies for replacement purposes. Among the best customers abroad are South Africa, India and Canada. Egypt has also placed some valuable orders, and is in the market for various other products. The heavy-machinery and engineering branches are accounting for substantial outputs, and the medium sections are meeting a heavy influx of orders. Makers of agricultural machinery, parts, and tools are building up stocks in readiness for the seasonal demand at the beginning of the year. Electrical equipment is a progressive line; traction motors are on order for South Africa and certain countries in South America. The special steel-making branches have sufficient orders on hand to maintain production at the present high level for many months. The tool trades are fully occupied and orders show no sign of decreasing.

South Yorkshire Coal Trade.—All classes of coal are moving freely. Industrial concerns continue to take larger tonnages, and stocks are growing at the majority of works. Steams are in steady demand, and house coal finds a ready sale.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—In contrast with experience at the local ports in previous years, coal-loading operations at the South Wales docks were available throughout the Christmas holiday period. This followed as a result of the agreement reached with the coal trimmers and tippers early this year. In the past, the lack of such facilities has been the subject of much complaint by shippers and shipowners, who have contrasted the hours of working at the ports at holiday times very unfavourably with those prevailing in the competing exporting districts of the North East Coast. Conditions on the steam-coal market showed little variation. On export account, only a limited inquiry was encountered, the chief interest being shown by Portuguese, South American and Eirean buyers. Deliveries to these destinations were maintained on a moderate level. Inland buyers, however, continued to display a keen interest in the popular high-volatile bituminous descriptions, which were needed for industrial purposes. Producers of these kinds, however, could handle little fresh business for some little time ahead owing to the heavy previous sales. On the other hand, there was not much business available for the dry steam descriptions, which received little attention and were freely available. Best large coals remained well placed with orders and the sized grades were scarce and firm. Bituminous smalls were difficult to stem for some time ahead, but supplies of dry smalls were in excess of requirements, despite the curtailment of output that has taken place, and the tone was dull. Cokes were in active request from inland buyers, but new business was checked by stemming difficulties. Patent fuel was slow.

The Iron and Steel Trade.—Activities were well sustained in the iron and steel and allied trades of South Wales and Monmouthshire during the week, in spite of the holidays. Works were occupied almost to full capacity, while stem lists were well filled ahead.

PRODUCTION OF MINERALS IN QUEBEC.—A statement issued by the Bureau of Mines of Quebec shows that, during the first ten months of the present year, 283,927 tons of asbestos, 842,545 oz. of gold, and 1,084,085 oz. of silver were produced by the mines in the Province. The outputs for the corresponding period of 1939 totalled 291,511 tons of asbestos, 705,960 oz. of gold, and 951,238 oz. of silver.

ROLLING-STOCK BUILDING INDUSTRY IN THE UNITED STATES.—Statistics prepared by the Association of American Railroads indicate that, during the first nine months of the present year, the main-line railway companies in the United States placed 52,685 new goods wagons in service, as compared with 14,704 in the corresponding period of last year. New locomotives put into commission during the first three quarters of 1940 totalled 265, of which 73 were steam engines and 192 electric or Diesel electric. The totals for the period ending September 30, 1939, were 45 steam and 157 electric or Diesel-electric locomotives, making a total of 202 engines.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—The general situation in the iron and allied trades may be described as satisfactory. The release of licences for the supply of tonnage during the first quarter of next year gave rise to some animation in the market. Buyers readily placed substantial orders and are desirous of negotiating for further supplies. The present large aggregate tonnage output, as well as the supplies of many commodities arriving from overseas, are passing promptly into use. The demand is increasing and the production of some descriptions of materials is at a maximum; imports, however, promise to meet all essential needs. Although strict enforcement of the control of distribution regulations is still necessary to ensure adequate deliveries of materials for work of national importance, the usual buyers anticipate some increase in the rationing of tonnage for general commercial purposes.

Cleveland Iron Trade.—Foundry-iron consumers are not permitted to accumulate stocks, but state that the regular deliveries are ample for their increased requirements. There is still only a moderate supply of Cleveland pig, the output of which continues to be intermittent; no movement to enlarge the make appreciably is yet noticeable. Adequate supplies of iron of qualities specified for particular uses are still obtainable from Scotland and other producing centres. The business passing through second-hands has increased slightly, but is still on only a moderate scale. The official values of Cleveland pig are based on No. 3 quality at 128*s.*, delivered within the Tees-side zone.

Hematite.—The gradual change for the better reported in the statistical state of the hematite branch of trade is due to the substantial and steadily increasing use of American iron, the import of which is expected to increase sufficiently to permit distribution on a scale sufficient for the increasing requirements of the consumers. The bulk of the output of local furnaces is absorbed at works owned by hematite makers, but deliveries to consumers who have to buy in the market have increased considerably. New orders for local iron, however, are difficult to place, as producers are still of the opinion that until they have greatly reduced their contract obligations they are not justified in adding to their commitments. The stabilised quotations for East Coast brands are ruled by No. 1 description at 138*s.* 6*d.*, delivered to North of England areas.

Basic Iron.—The fixed nominal figure for basic iron remains at 120*s.* 6*d.* Although there is none for sale, the output is still ample for the heavy requirements of the makers' own steelworks.

Foreign Ore.—Imports of foreign ore are satisfactory, and consumers have considerable stocks.

Blast-Furnace Coke.—There is little business passing in Durham blast-furnace coke. Sellers have well filled order books, and local users have covered their requirements as extensively as they consider to be advisable. The price of good medium qualities is 35*s.* 6*d.*

Manufactured Iron and Steel.—The supply of semi-finished iron and steel is fully equal to the extensive requirements of the re-rolling mills; makers are turning out increasing tonnages and imports from the United States are substantial. The pressure for delivery of constructional steel has eased somewhat, but the demand for shipbuilding requisites and special steels is unabated. Among the principal market quotations are:—Soft steel billets, 12*l.* 5*s.*; hard billets, 13*l.* 12*s.* 6*d.*; joists and sections, 15*l.* 8*s.*; heavy plates, 16*l.* 3*s.*; and heavy rails, 14*l.* 10*s.* 6*d.*

Scrap.—Merchants and users have large stocks of iron and steel scrap.

PAPER MAKING IN CANADA.—The production of newsprint paper in Canada in the first eight months of 1940 totalled 2,300,000 tons, compared with 1,800,000 tons in the first eight months of 1939. The total for 1940 represents an increase of nearly 27 per cent.

THE INSTITUTE OF PETROLEUM.—The Council of the Institute of Petroleum offers a Medal and Prize (to the value of 5*l.* in books) for the most meritorious essay, submitted by a student member of the Institute, on various subjects connected with deep drilling, water shut-off, deep-well surveying, petroleum fractions, thermal cracking, lubricants and motor spirit. Entries are also invited for the Burgess Prize, which has a value of up to 5*l.* in books, for an essay dealing with some aspect of the economics of the petroleum industry, including the transport and distribution of petroleum products. In both cases, entries must be received by the Secretary of the Institute, c/o The University of Birmingham, Edgbaston, Birmingham, 15, not later than May 1, 1941. The maximum length of essays is not specified, but generally they should be from 4,000 to 6,000 words in length.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, January 2, 12.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Ordinary Meeting for formal business only.

INSTITUTION OF MECHANICAL ENGINEERS.—Friday, January 3, 2 p.m., Storey's-gate, St. James's Park, S.W.1. Special Informal Meeting. Discussion on "The Control of Oil Fires," to be opened by Mr. A. F. Dabell.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—There has been no abatement during the past week in the activity in the Scottish steel trade, which has been general throughout the year, and all the works are fully employed on essential work. Heavy steel is in regular demand, shipbuilders and boiler makers both pressing for deliveries. Structural material is also in steady demand and as consumers have many urgent contracts to fulfil, their requirements are heavy and deliveries are quickly consumed. The makers of black and galvanised sheets are exceptionally busy, and production has been speeded up. This is also true regarding galvanised sheets, the demand for which continues on a high level. Supplies of scrap have been very satisfactory of late and the output of steel has not been hampered. The following are the current quotations:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—Conditions are still satisfactory in the malleable-iron trade of the West of Scotland and there is a steady demand for deliveries. The re-rollers of steel bars have well filled order books and as there are ample supplies of semies the works are kept fully employed. The market prices are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—The demand for Scottish pig-iron is such that all the furnaces in blast are being operated at their full capacities. Every ton of steel-making iron is urgently required and the production is rapidly taken up. There is less pressure for foundry grades of iron, although a satisfactory business is going through. The following are to-day's market quotations:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steelworks; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

ROAD-VEHICLE ORDER FROM SCOTLAND.—The Scottish Motor Traction Company, Limited, has recently ordered 60 single-deck and 10 double-deck oil-engined coaches and omnibuses from the Associated Equipment Company, Limited, Southall, Middlesex.

STEEL HELMETS.—The Minister of Transport states that the Ministry of Home Security has agreed that mild-steel helmets may be supplied to road-transport workers, engaged on essential services, as they become available. This helmet does not afford the same degree of protection against direct rifle or machine-gun fire as the Service steel helmet, but it is considered to give adequate protection against falling debris, spent shrapnel and shell splinters. The price of the helmet is 7*s.*, and road-transport undertakers desiring to be supplied with helmets should submit an application to the appropriate Regional Transport Commissioner. Applicants should confine their initial requirements to the bare minimum.

MANGANESE IN STEEL MANUFACTURE.—According to figures published by the American Iron and Steel Institute, 13 lb. of manganese metal are consumed for every net ton of finished steel produced. Thus, it is calculated that, in a year of active operation, the United States steel industry requires nearly 540,000 net tons of metallic manganese. In recent years, the American output of high-grade manganese ore has averaged only about 35,000 tons per annum. The remainder has, therefore, to be imported, and, in the first eight months of the present year, Soviet Russia supplied about 35 per cent. of the high-grade manganese ore brought into the country, 30 per cent. came from British possessions in Africa, 10 per cent. from Cuba, and 9 per cent. from Brazil. The remainder came from India, the Philippines, and other sources.

TRANSFORMERS FOR ELECTRIC FURNACES.

CONSTRUCTED BY MESSRS. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, RUGBY.

(*For Description, see page* 504.)

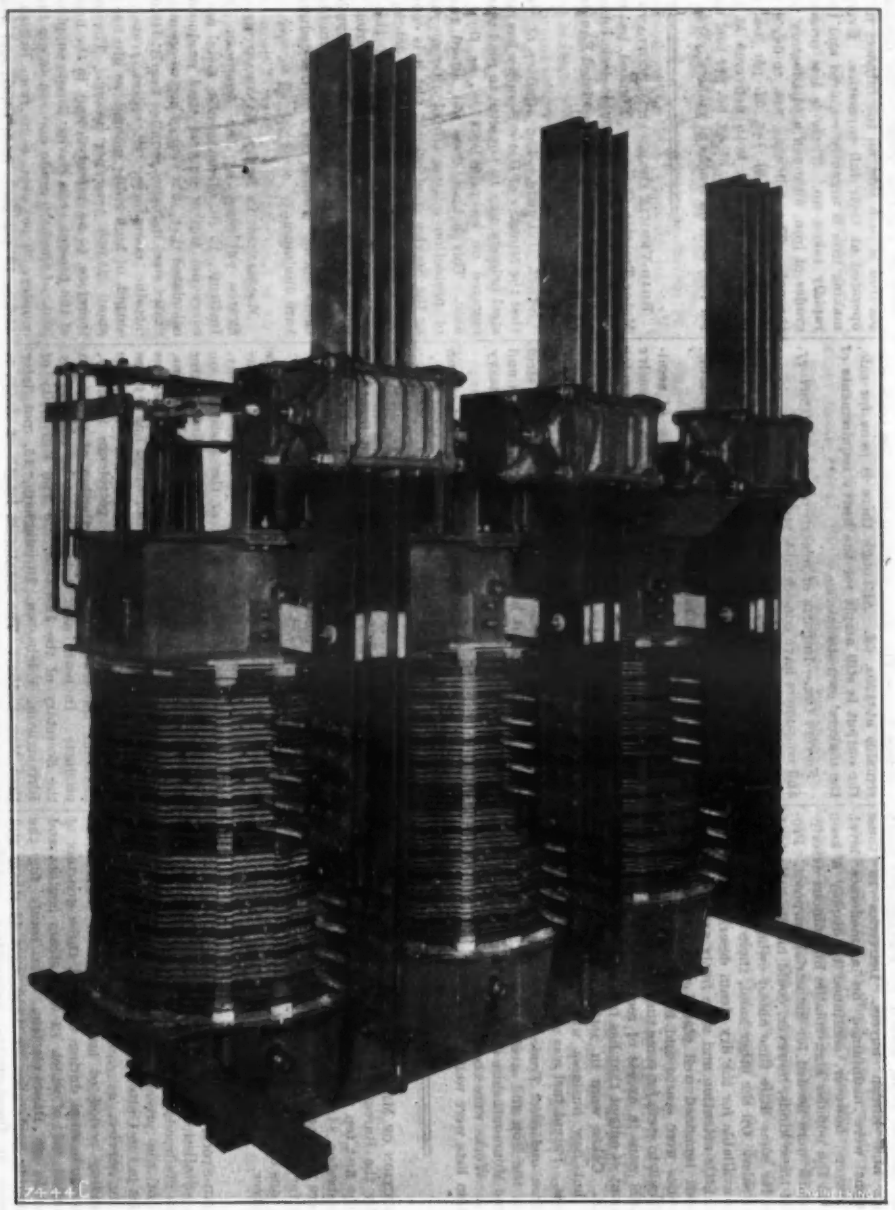


FIG. 3. 2,460-KVA 20,000/180–79-VOLT FURNACE TRANSFORMER.

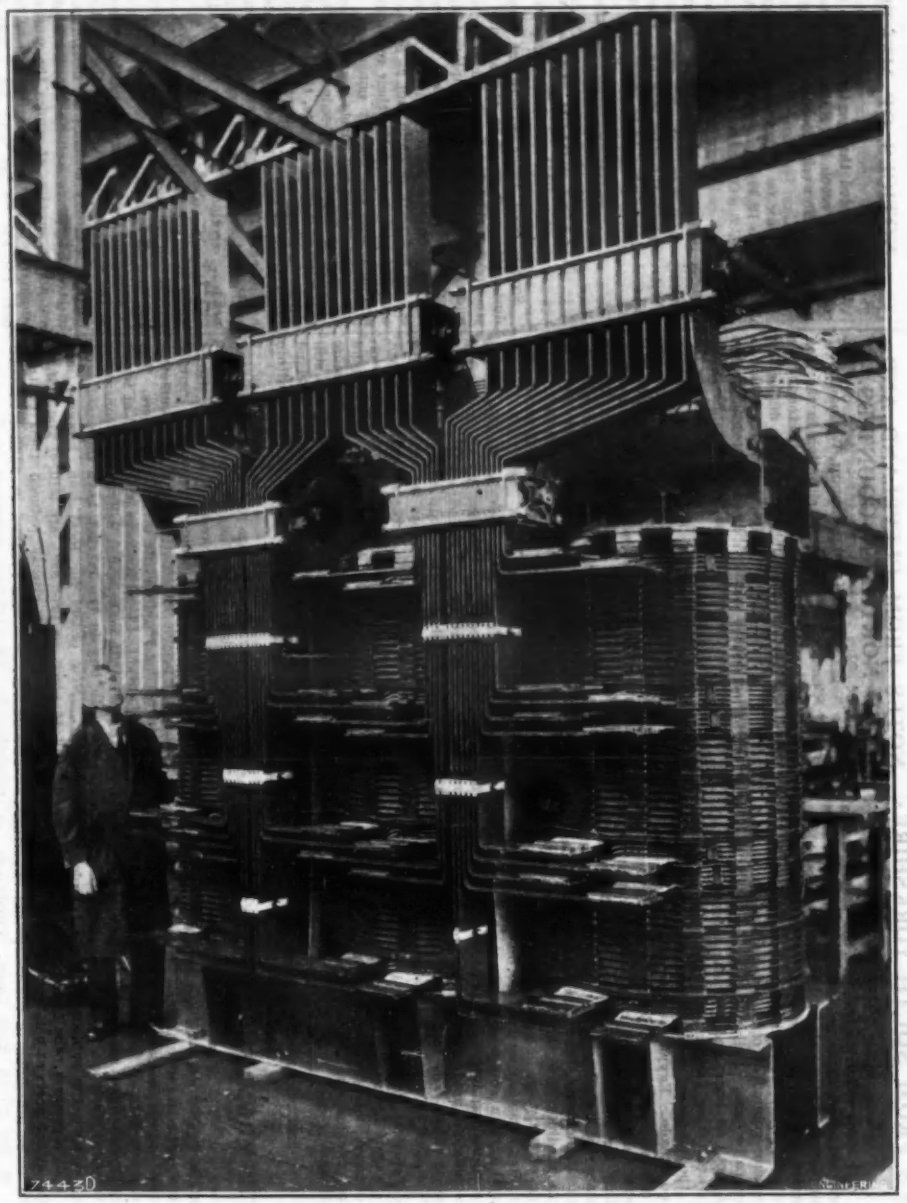


FIG. 4. 8,400-KVA 6,600/246–84-VOLT TRANSFORMER WITH INTERLEAVED WINDINGS.

ENGINEERING.

Offices for Publication and Advertisements, 35 & 36, Bedford Street, Strand, London, W.C.2.

We desire to call the attention of our readers to the fact that the above is the address of our Registered Offices, and that no connection exists between this Journal and other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS { "ENGINEERING," LESQUARE LONDON.

TELEPHONE NUMBER—TEMPLE BAR 3663 (2 lines).

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months (or for six or three months, *pro rata*), payable in advance :—

For the United Kingdom	£3	5	0
For Canada—			
Thin paper copies	£2	18	6
Thick paper copies	£3	3	0
For all other places abroad—			
Thin paper copies	£3	3	0
Thick paper copies	£3	7	6

Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages six words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns, of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The Proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

All accounts are payable to "ENGINEERING," Ltd. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

TEMPORARY ADDRESS.

For the duration of hostilities, the Editorial and Publishing business of this Journal is being conducted from 18 and 20, Compton Road, Hayes, Middlesex. The Telephone Number of the Editorial Department is Hayes 1730, and that of the Publishing Department, Hayes 1723. The Bedford Street Offices are open on Fridays only, between 10 a.m. and 5 p.m., for the distribution of the current issue and for retail sales.

CONTENTS.

	PAGE
The Machining of Abrasive Timber (*Illus.*)	501
Literature.—Philips Practical Welding Course. Methane: Its Production and Utilisation	502
Developments in Wood Technology (*Illus.*)	502
Transformers for Electric Furnaces (*Illus.*)	504
Direct-Reversing Marine Diesel Engine (*Illus.*)	505
Annuals and Reference Books	508
Books Received	508
Tender	508
Personal	508
Notes from South Yorkshire	509
Notes from the South-West	509
Notes from Cleveland and the Northern Counties	509
Notices of Meetings	509
Notes from the North	509
The Parsons Memorial Lecture	511
The Economic Future	512
Notes	513
The Physics of Air Raids (*Illus.*)	514
Letter to the Editor.—Fifty Years of Pressure-Scavenging	514
The Late Sir Harley Dalrymple-Hay (*with portrait*)	515
The Late Mr. Henry J. Spooner	515
Wire Butt-Welding Machine (*Illus.*)	516
Spoil-Moving Equipment	516
The Use of Diesel Engines in Mines	517
Labour Notes	517
Progress in the Design of Mining Electrical Equipment	518
Vibration Patterns of Propeller Blades (*Illus.*)	518
The Port of Rangoon	519
"ENGINEERING" Patent Record (*Illus.*)	520

Two One-Page Plates.—THE DEVELOPMENT OF WOOD TECHNOLOGY. DIRECT-REVERSING DIESEL MARINE ENGINE.

ENGINEERING

FRIDAY, DECEMBER 27, 1940.

VOL. 150. No. 3911.

THE PARSONS MEMORIAL LECTURE.

THE organisation of memorial lectures to commemorate famous engineers, and particularly the maintenance of a sufficiently close connection between the subjects of the successive lectures and the interests of the individual commemorated, present problems of increasing difficulty as the number of such foundations continues to grow. Given a wide enough choice of subject, there is no lack of qualified lecturers whose discourses can be depended upon to maintain a standard that will do justice to the occasion; the real difficulty arises when, a number of years having passed, it is no longer possible to restrict the scope to the particular branch of engineering or science which was the concern of the person memorialised. The Thomas Hawksley Lectures of the Institution of Mechanical Engineers, for example, were intended to have reference, "as far as practicable," to those branches of engineering, namely, water supply, gas supply, and main drainage, with the development of which Thomas Hawksley himself was concerned; but in course of time the lectures have become occasions for excursions into fields far removed from the original concept, and are now accepted as opportunities to explore, under expert guidance, almost any specialised department of applied science.

When the Sir Charles Parsons Memorial Lecture was founded by the Council of the Royal Society, with the aid of funds collected for that purpose, to commemorate the work of the late Sir Charles Algernon Parsons in engineering and in science, pessimists were not wanting who foresaw some similar departure from the original intent; but they failed to appreciate the versatility of Sir Charles Parsons, which enabled the Council to introduce a novel rotation of venue and to take full advantage of an almost embarrassing variety of subjects. Under the arrangement adopted, the annual lecture is given in London to the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Institute of Marine Engineers, the Physical Society, and the Institution of Electrical Engineers in turn; but in every fourth year it is to be delivered alternately in the North of England, before the North-East Coast Institution of Engineers and Shipbuilders, or in Scotland, before the Institution of Engineers and Shipbuilders in Scotland. In each case, the institution or society concerned makes all the necessary arrangements, but the actual appointment of the lecturer is made by the Council of the Royal Society. The first lecture of the series was delivered in 1936 before the North-East Coast Institution by Sir Frank Smith, K.C.B., who took as his subject, "Sir Charles Parsons and Steam." The second, by Dr. Gerald Stoney, F.R.S., on "The Scientific Activities of Sir Charles Parsons," was given before the Institution of Electrical Engineers in the following year. Mr. S. S. Cook, F.R.S., gave the third lecture, on "Sir Charles Parsons and Marine Propulsion," before the Institution of Mechanical Engineers in 1938; and Dr. H. L. Guy, F.R.S., prepared the fourth lecture, on "Some Researches on Steam-Turbine Nozzle Efficiency," for delivery before the Institution of Civil Engineers in December, 1939. Owing to war conditions, the meeting had to be cancelled, the lecture being eventually published in the *Journal* of the Institution. The first lecture had been given in Newcastle-upon-Tyne in recognition of Sir Charles's close connection with Tyneside throughout his working life; and it followed, therefore, by the operation of the four-year rule, that the 1940 lecture should be delivered before the Institution of Engineers and Shipbuilders. Actually, however, it was given on Tuesday, December 17, before the North-East Coast Institution, the lecturer being Sir Stephen J. Pigott, D.Sc., managing director of Messrs. John Brown and Company's shipyard and engine works at Clydebank.

How this arrangement came about is immaterial, but it is interesting in that it caused Dr. Pigott's lecture on "The Engining of Highly Powered Ships," to follow immediately, in the programme of the North-East Coast Institution, upon a paper by Mr. L. M. Douglas on "Power Transmission in Marine Propulsion." It is tempting to review the two discourses in conjunction, for they were complementary to an unusual extent, Mr. Douglas having been associated with Sir Charles Parsons' work in the application of gearing to marine propulsion from its inception; but the Parsons Lecture is an event of sufficient importance to deserve separate consideration, and, in any case, it invites that consideration to be from a somewhat different angle in view of the historical interest of its quotation from the report of the special committee which recommended the adoption of turbine propulsion in the Lusitania and Mauretania. In the light of subsequent developments, the composition of this committee is interesting. It was appointed in August, 1903, by the directors of the Cunard Company, and consisted of their superintendent engineer, Mr. James Bain, as chairman; with Engineer Rear-Admiral H. J. Oram (afterwards Engineer-in-Chief of the Fleet) to represent the Admiralty; Sir William H. White, formerly Director of Naval Construction, representing Messrs. Swan, Hunter and Wigham Richardson; Mr. Andrew Laing, for the Wallsend Slipway and Engineering Company; the Hon. Charles Parsons (as he then was), representing the Parsons Marine Steam Turbine Company; Mr. J. T. Milton, chief engineer surveyor of Lloyd's Register of Shipping; Mr. (now Sir) Thomas Bell, of Messrs. John Brown and Company, Clydebank; Mr. William Brock, of Messrs. Denny Brothers, builders of the pioneer turbine steamers King Edward, Queen Alexandra and Queen; and, as secretary, Engineer-Lieutenant W. H. Wood, R.N., who subsequently left the Navy to become engine-works manager at Clydebank. It may be observed that Sir Thomas Bell is now the sole survivor of this committee, which exerted so great an influence on the whole trend of marine propulsion, both mercantile and naval, throughout the world.

Broadly speaking, Dr. Pigott observed at the outset, the development of the mechanical propulsion of high-powered ships fell into four main divisions, namely, reciprocating steam engines; steam turbines directly connected to the propeller shafting; steam turbines mechanically geared to the propeller shafts; and turbo-generators transmitting power electrically to motors on the propeller

shafts. The total tonnage of ships in the "highly powered" class, he continued, was only a very small proportion of the total world tonnage, yet the task of providing suitable propulsion for this comparatively small number of ships had played an important part in the progressive improvement in methods of ship propulsion. The leading ships of the first of the four classes, between 1893 and 1902, were the Campania and Lucania of the Cunard Line, and the German liners Kaiser Wilhelm der Grosse, Deutschland, and Kaiser Wilhelm II, in which the propelling machinery progressed from five-cylinder triple expansion engines developing 15,000 indicated horsepower per set, to four-cylinder quadruple-expansion three-crank engines, coupled in tandem, and giving, on the record voyage, 22,300 i.h.p. per set.

The more that retrospective consideration is given to the eventual decision of the committee, "that it would be justifiable to adopt Parsons' turbines for these vessels, despite the absence of experience in connection with turbines of such large size," the more remarkable does that decision appear. It was not merely that no steam turbines even remotely approaching the desired power were in service or in existence; whatever type of machinery was to be adopted, the power of the machinery was to be at least 50 per cent. greater than that of any other ship afloat. There is the possibility, of course, that this factor exercised a decisive influence; vibration, in existing ships, was sufficiently marked for a possible increase, with so great an advance in power, to be regarded as a serious matter. The extracts from the report make this quite clear: ". . . with reciprocating engines, placed in the only available positions in the ships, the vibration would be troublesome," as "the engines could not be perfectly balanced even by the largest balancing weights it would be advisable to use. With turbines, however, the vibration due to the engines would be practically nil." The further point was made that, with reciprocating engines, the diameter of shafting required would be greater than any within the experience of either the manufacturers or of users on board ship. So far as it is permissible to read between the lines of the report, however, it would appear that the question of vibration was the most influential single item in the comparison of reciprocating engines with turbines. Vibration may have been the *motif* underlying the statement (otherwise a little difficult to appreciate after such a lapse of time) that "the Committee recognise that the experience gained in the design and manufacture of such high-powered reciprocating machinery will be of service in dealing with large turbines." Be that as it may, the turbines were built and installed; and eventually, in the case of the Mauretania's record run in 1929, they reached 80,000 shaft horsepower, which, it is safe to say, the reciprocating machinery never could have done.

The combination of reciprocating engine and turbine may be passed over, together with the increased favour accorded to the impulse turbine, with the fitting of which in the battle cruisers Repulse and Renown, "the application of the direct-connected turbine progressed in ships of His Majesty's Navy to a power level much in excess of the highest achieved with this type of power transmission in naval vessels," to quote Dr. Pigott, who pointed out, however, that the increase was in power rather than efficiency, owing to propeller losses at high revolutions. In 15 years, he stated, engine power had increased three-fold, yet the relative saving in fuel was less than 10 per cent. The next point of historic technical significance was the introduction of gearing. In general, the story is well known, but the lecturer showed parts of it in a new light in his remarks about H.M.S. Hood, of over 150,000 shaft horse-power—"the first highly-powered geared installation," and "to the present day, the most highly-powered capital ship in any of the world's navies." The detail of particular interest, he observed, was that the adoption of gearing in the Hood was not dictated by necessity, as it would have been quite practicable to have propelled her by direct-drive turbines. This is a point, we believe, which is not generally appreciated; at all events, not so generally as the further statement, that propulsion by geared turbines could not have been adopted on such a scale, but for the parallel development of the single-collar thrust block. From the particulars given in the lecture of various modifications made to the machinery of the Queen Mary, after experience on trial and in service, it is clear that vibration was again assuming prominence, as in the case of the Lusitania; although, in this instance, its extent was relatively very much less serious, and comparatively easily cured. The risk of excessive torsional oscillation in the main shafting was obviated by the use of the "quill" drive on a scale not hitherto approached on board ship; and, for the rest, steps were taken to ensure that no vibration should be set up in the turbine blades by the cumulative effect of the steam jets inpinging upon them. Looking back to the turbines of the Lusitania and Mauretania, it is impressive to consider what advances have been made in those 35 years or less in the stressing of engineering materials. Unfortunately, the training and the skill which contribute to such development are of an order that is not readily "understanded of the people," nor can they be effectively imparted to more than a very few per cent. of the many thousands of men whose collective effort is represented by the finished ship. If only this fact could be more widely realised, less might be heard of the wonderful schemes for wholesale "up-grading" and "equality of status," based, apparently, on the mere counting of heads, without much regard to what may or may not be inside them. The highly-powered ships have never been numerous, but they have showed the way to millions of tons of less spectacular craft. After all, there can be only one Parsons Lecturer in a year; and one Parsons in a century would be a better measure than the world has any right to expect.

THE ECONOMIC FUTURE.

ONE of the first actions of Mr. Churchill's Government was to call upon all those engaged in the production of munitions—using that term in its widest sense—to exert every effort to increase the output to the utmost. It is probable that some such call would have been necessary in any case, as soon as quiescence gave place to activity on the Western Front; it became doubly essential when events in that field took an unfavourable turn; and, now that Germany may be supposed to have had time to digest her captures in Belgium, Holland and France, and to prepare the next stroke, the need is still for the maximum output to ensure an adequate reserve of arms and other equipment. To make good the earlier losses, to provide all necessary arms and other supplies for the forces actually embodied, and to store up a sufficient reserve for the more active campaigning that has now begun in the East, and may be expected to extend shortly to the West: these are by no means all of the demands that the industries of the nation and the Empire must continue to meet. Notwithstanding the calls for military supplies, it is essential that export trade shall be maintained at the highest possible level, both for the purpose of paying for imports which are urgently required, and to retain and extend the goodwill of British business in such neutral markets as remain. Through the medium of the Export Council and the Export Groups, the Board of Trade has been making very strenuous endeavours to stimulate export trade, and these efforts have been rewarded by an encouraging measure of success.

Under the stress of war, industries and individuals alike have cheerfully acquiesced in the imposition of emergency legislation, not always prepared with the degree of forethought that should accompany the surrender of long-standing liberties, designed to ensure that the fullest use is being made of the whole of the nation's resources, public and private. There is some reason to suppose that strenuous efforts will be made, when the war is over, to establish much of this departmental control on a permanent basis. The same tendency was quite plainly in evidence at the close of the war of 1914-18, and some of the temporary departments, created to meet the needs of that conflict, are still in existence and may be regarded, now, as fully-established sections of the public services. Most of them succeed in justifying their retention to a certain extent, although few can be regarded as absolutely essential; and, under war conditions, some departments—for example, the Ministry of Transport—are able to exert a valuable co-ordinating influence which may induce a temporary forgetfulness of the multitudes of vexatious regulations that were the chief fruits of their labours in time of peace. If trade and industry are to be set firmly on their feet again, on the conclusion of the present hostilities, it is highly desirable that the people who will have to do the real work of reconditioning the damaged factories, recommencing their normal manufactures, and re-establishing contact with their former customers (many of whom are certain to be in an even more parlous state), should be allowed to do so in their own way, and with the absolute minimum of supervisory officiousness and form-filling.

There is a lesson on this topic to be learned from the study of Nazi economics, as described in F. Borkenau's book, *The Totalitarian Enemy*. When the Nazis came into power, according to Mr. Borkenau, they found, ready made, very elaborate machinery for the all-round control of the economic life of Germany. Wage rates had been fixed, and both collective bargaining and compulsory arbitration had been introduced. A serious attempt had been made to institute an effective control of commodity prices, and many industries were under Government supervision through the medium of the banks, which, as is well known, have played a very active part in the direction of German industry in recent years. Rigid control of foreign exchange had been established, and thus, in one way and another, the Government of the day was in a position to exert an almost absolute control over production, marketing, imports, and, indeed, every department of trade. It is important to note that these changes had been introduced as temporary measures, to counteract the injurious effects of the general slump in world trade; not out of antagonism to private capitalism. The Nazis, however, made them into a permanent system, partly to keep the industries of the country from immediate dissolution, but mainly to facilitate their programme of armaments production.

From the last-mentioned standpoint, this top-heavy control organisation may be held to have justified its existence; but, from the point of view of the great majority of the actual producers, it must have appeared in a very different light, for it has brought real prosperity to no one—certainly not to the workpeople, and only in a very restricted degree to the owners of the capital invested in the industries. Wages reached low levels that they never touched during the worst of the slump in 1932, hours of work have been steadily increased, and ruthless methods of speeding-up have been applied. The individual is assigned his work, and is no longer at liberty to leave it; while the maintenance of such immense military forces has led to a general shortage of labour, which has been only partly ameliorated by the importation of prisoners of war from Poland and other countries—an earnest of the new type of slavery, which recent Nazi spokesmen have openly declared their intention to enforce as one of the basic features of their "new social order." Mr. Borkenau discussed in detail the position that gradually developed as the result of these conditions, but it is not necessary to follow him through these particular arguments. The significant fact is that, in order to combat the Germany thus unified by decree, Britain has been obliged to adopt similar tactics in the organisation of the nation's finances, industries, overseas trade, and—nominally, at least—the person and property of every individual citizen. The danger is not that these far-reaching powers will be used in time of war, for to do so on any extensive scale might easily slow up the war effort more than accelerate it; but that the promise to restore the pre-war freedom of the ordinary citizen may not be implemented. Obviously, all the restrictive ordinances cannot be swept away by a single stroke; but it would be the height of irony if a war undertaken to secure national freedom should result in the virtual disappearance of the freedom of the individual, upon whom, after all, the functioning of the national machine depends.

NOTES.

COLOUR TELEVISION.

ALTHOUGH the television broadcasts of the British Broadcasting Corporation ceased on the outbreak of war and the activities of many of those engaged in the technical development of television have been utilised since then on matters of more immediate importance, there is every reason to suppose that the broadcasts will be resumed and the technical development continued after the conclusion of hostilities. For this reason it may be of interest to refer to a system of colour television developed by Mr. John Logie Baird and recently demonstrated by him at his laboratory, 3, Crescent Wood-road, Sydenham, London, S.E.26. In the receiver demonstrated, which has been designed for domestic use, the picture is seen in natural colours on a ground-glass screen 2 ft. 6 in. wide and 2 ft. high, but the same apparatus could be used for receiving the B.B.C. television broadcasts in monochrome; and the set also incorporates an all-wave radio receiver and an automatic record-changing gramophone. Detailed technical particulars of the system are not yet available for publication, but the principle employed may be summarised as follows: The head and shoulders of a human being, or any other coloured object, are scanned by a spot of light produced by the optical projection of the moving spot formed on the screen of a high-voltage cathode-ray tube. Between the tube and the projection lens is a rotating disc carrying two transparent filters of red and blue-green colour, respectively, the scanning speed and the speed of rotation of the disc being adjusted so that the object is completely scanned by red light and blue-green light alternately. The light diffusively reflected from the object is picked up by photo-electric cells and the resulting high-frequency electrical impulses are amplified and supplied to a radio transmitter. In the demonstration, since radio transmission by private individuals is not now permissible, and as the transmitting apparatus was situated in a separate building only a few yards from the receiver, a land line was used as a connecting link between the two. At the receiver, the transmitted impulses are applied in the usual way to a cathode-ray tube and the pictures produced on the screen of the latter are sufficiently brilliant to enable them to be projected optically on to a ground-glass screen of the dimensions previously mentioned. It will be obvious that, with the arrangements so far described, pictures containing respectively the blue-green and red components of the colours of the transmitted object would be received on the screen in rapid succession, but they would be seen only in monochrome. To give colour reception it is necessary to introduce a rotating colour disc between the cathode-ray tube of the receiver and the projecting lens, and this disc must be rotated in synchronism with that used in the transmitter. When this is done, the viewer sees a red picture and a blue-green picture superposed with such rapidity that the two blend and the colours of the transmitted object are reproduced with sufficient accuracy to give a pleasing result. We understand that, if the transmission of colour television should be undertaken in the future, the transmissions could be received in monochrome in existing television sets.

ELECTRICAL ENGINEERS' BENEVOLENT FUND.

There is more than one reason why the financial position of the benevolent funds of British engineering institutions is likely to be adversely affected by war conditions. In the first place, the calls on the public's charitable purse have been extended, both in number and depth, while not all professional men have benefited from higher salaries since September, 1939, though the cost of living has risen and is rising in many directions. On the other hand, the increasing age of the members of these bodies has inevitably resulted in the demands on the funds becoming more insistent, while casualties on all fronts have naturally had the same effect. The position is well summed up in a statement which has been issued by Mr. J. R. Beard, President of the Institution of Electrical Engineers. In this, he points out that in recent years the position of the Benevolent Fund of that body has been causing some anxiety as the income from all sources, including investments, has been falling below the minimum expenditure necessary to deal with the many necessitous cases brought to the notice of the Committee of Management. This is not due to over generosity, since grants are only made after personal investigation and an examination of the cases assisted shows that the necessity is always real and urgent. In spite of the fact that the successive efforts of recent presidents and the assistance given by local-centre committees have improved the position somewhat in the last year or so, matters are by no means satisfactory, especially if it is postulated that the invested funds should have increased at a rate commensurate with the Institution's increased membership and importance. Moreover, there is likely to be a considerable loss of income during the current year owing to the abandonment of the Electrical Engineers' Ball and of the many social activities in the local centres which could normally be relied upon for substantial contributions. It is therefore hoped that, despite the difficult financial circumstances, subscriptions will not only be fully maintained, but even increased, as the cause is considered one which should have a high priority claim on the membership. Mr. Beard specifically appeals for assistance to industrial firms and public utility undertakings, whose technical staffs include so many members of the Institution. In addition, however, he points out that only 6,600 out of the 20,000 members are subscribers at all and that the average amount provided by each subscriber is only 3*s*. 8*d*. He therefore hopes that present subscribers will, if possible, increase their subscriptions, that more members will subscribe, and that, in particular, the numerous overseas members who, in many instances, may be less financially harassed than those at home, will participate. We trust that this appeal will not fall on deaf ears.

THE POST OFFICE IN WAR-TIME.

A meeting of the Council of the London Chamber of Commerce, on Tuesday, December 10, was attended by the Postmaster-General (the Rt. Hon. W. S. Morrison). He gave some account of the work of his department, which deserves wide publicity considering how the sometimes inevitable defects in the postal, telephone and telegraph services are adversely affecting the trade and industry of the nation. Mr. Morrison began by assuring the Chamber that he realised the responsibility of the Post Office to give such a service to the business as would enable it to function with regularity in providing the sinews of war. He pointed out that the Post Office could not evacuate. It was anchored by its duty to the public everywhere, and by its vast capital equipment. He also emphasised its dependence on the railways. At the outset of the "blitzkrieg" the staff had taken cover at the sound of the siren. Now, however, it carried on until the imminent danger signal had been given and sometimes even disregarded that. Loss of working time had already been reduced on an average by 90 per cent. The postal services worked a great deal at night in the black-out and many of the staff carried on voluntarily under conditions of risk corresponding to those of the A.R.P. services. On the railways, the peace-time standards to which the Post Office had been accustomed were clearly no longer practicable. Their problem was, therefore, to devise a better system which would give business what it wanted, namely, something on which it could rely. They were co-operating with the railways to achieve that end. They were working to get the bulk of the mail out in the day time instead of at night, and they hoped to arrange that mail posted in Central London up till 1 p.m. would be delivered in the provinces on the following morning. Letters posted in London up to 5.30 p.m. or 6 p.m. would be delivered some time during the following day. The fullest possible use was being made of road transport. Regarding the telephones, Mr. Morrison emphasised the difficulties thrown upon the Post Office by war conditions. They had to provide service for the Air Force, the Navy and the A.R.P., and, since the French capitulation, for Army purposes on a scale not previously contemplated. A priority system was inevitable in the circumstances, but Mr. Morrison appreciated the justice of the claim of the business community that such a system should not be abused, and gave an assurance that the Post Office were working in every possible way to prevent any abuse. He mentioned that they were considering means of notifying the public when a line was likely to be out of order for any appreciable time, so that subscribers need not go on trying to get through without result.

COLOUR BLINDNESS AND AIR OBSERVATION.

An interesting account of the effect of colour blindness on the spotting qualities of air observers is given in the current issue of *The Times Trade and Engineering Supplement*. As in all other countries, observers in the United States Air Corps have to pass very exacting tests. For one of these, the candidate is flown over a well camouflaged area and ordered to try and identify as many military targets as possible. When tests of this kind were being carried out on a large scale, a month or so ago, it was found, to the surprise of the authorities, that many of the trained observers did extremely badly, some even failing to single out one of the many objectives in the area covered. The question naturally arose whether this was due to bad spotting or whether the particular camouflage was more than usually effective. To decide which was the correct explanation, an artillery observer who had, of course, been trained for gunnery spotting only, was taken up. He succeeded not only in locating all the gun positions in the area, but a number of other military targets. Optical tests were carried out to discover whether he possessed exceptionally good eyesight, and it was then discovered that he was colour blind. For that reason, camouflage had not deceived him in the slightest. Thanks to this chance discovery, it is stated that the United States Air Corps are now considering to what extent they can benefit by men's colour blindness. The question is a difficult one to decide, because if an air observer is colour blind, although he might be able to identify a camouflaged target rather more easily than a man with normal vision, from a bombing point of view he would be handicapped by his inability to distinguish colours and also to distinguish signal and other lights. For this reason, it is thought possible that the authorities may consider that the disadvantages outweigh the advantages, and that on the whole a colour-blind observer would be less useful than one with normal sight. The discovery, however, is interesting, and even if it proves to have no value from the point of view of air operations, it may prove useful in other war operations, such, for instance, as anti-aircraft gunnery.

THE MELCHETT MEDAL.

At the meeting of the Institute of Fuel which was held at the Connaught Rooms on Thursday, December 12, 1940, the President, Lieut.-Colonel J. H. M. Greenly, C.B.E., announced that the Melchett Medal for 1940 had been awarded to Professor Etienne Audibert, of France. He added that a strong committee in France, under the Presidency of M. Dautrey (who was the French Minister of Armaments) had recommended Professor Audibert as being the most suitable recipient. Unfortunately, since the disastrous happenings of last summer, the Institute had not been able to get into touch with any of its French friends, and, in particular, with M. Audibert. Therefore, all that could be done was to announce the award and to keep the Medal in safe custody until it could be presented at a later date. The Students' Medal, for the best students' paper for 1940, was presented to Mr. L. H. F. Nichols, of the research staff of the British Coal Utilisation Research Association. His paper was entitled "Gas Sampling and Temperature Measurement in the Fuel Bed." The medal was accompanied by a prize of books. A special prize, consisting of books, was presented to Mr. H. Buckley (a member of the staff of the Paterson Engineering Company), for a paper which the adjudicators had considered to be very well worthy of a second award.

THE PHYSICS OF AIR RAIDS.

IN opening his lecture on the above subject, delivered at the Royal Institution, on December 3, Professor D. Bernal, M.A., F.R.S., said that an explosive charge did not contain more actual energy than a similar weight of fuel, but released it in a very brief interval of time. Taking as an illustration the case of a car having five gallons of petrol in the tank, he said that this would be expended in about a five-hour run. A similar weight of high explosive, on the other hand, released all its energy in about a twenty-thousandth of a second, and would thus expend something like four billion horse-power in that instant. One result of such conditions was that the waves set up were propagated in a quite abnormal manne. because the normal physical constants of materials were no longer valid. Thus, in the usual formula for the velocity of a wave of elastic compression, viz., $V=\sqrt{\frac{E}{\rho}}$, the value of E increased enormously at the extreme conditions of an explosion wave, E being, of course, the elastic modulus of the material and ρ the density. Even in such an elastic material as steel, the velocity was 20 per cent. greater than that for normal conditions, and in an air wave, γ (the ratio of the specific heats under adiabatic and isothermal conditions, respectively) increased from a value of 1·5 under normal conditions to 5 or 6 under blast conditions. The result of this was to change the wave form, from a smooth sinusoidal curve of compression and rarefaction, to a high-frequency compression front with a low-frequency suction following. The slide reproduced in Fig. 1 was shown by the lecturer to illustrate the resulting values of pressure and suction at increasing distances. The compression-wave, owing to its high frequency, was transmitted mainly in straight lines, whereas the lower-frequency longer-period suction-wave could turn corners and act out of the straight line.

An analogous case, he said, was provided by the behaviour of light waves which, when an obstacle interposed in their passage was of the same order of magnitude as the wavelength, gave diffraction patterns in the region of the geometric shadow. For this reason, the wandering propensities of suction waves, which are of the same order of wavelength as the obstacles they encounter, could be more easily understood and the erratic manner in which windows were pulled out round corners from the locality of an explosion could be explained. On the other hand, a blast wall of sufficient strength formed an effective obstacle to the direct action of the high-frequency compression wave and the desirability of erecting such a safeguard across the entrance of a shelter, for example, would be obvious from the fact that the compression front of the wave might be sufficiently intense to cause serious injury.

The form of the pressure wave was, of course, greatly modified if the explosion acted in a confined space instead of in the open. The uniform initial growth of pressure was then usually amplified by reflections from surfaces and obstacles into an irregular humped curve. This explained the destructive distribution of pressure that occurred in certain directions inside buildings. The main effect of blast, however, was a violent push followed by a powerful but slow pull. The high-speed cine-camera had been employed to study the behaviour of windows of varying thickness and size, braced and strengthened in different ways, when subjected to explosions of varying intensities. The actual window movements could be seen in profile if they were reflected in a large mirror set to one side; light index pointers were fixed on the window surfaces and their movements, in the plane of the glass or at right angles to it, were thus readily followed. In all cases previous to the actual fractures, when these were produced, the initial outward push and succeeding steady pull, could be seen. The effect might be increased or diminished according to whether the vibration period of the sheet of glass was in phase or out of phase with the blast-wave components. It was even possible to brace a window into resonance and thus increase the risk of fracture. This was illustrated by the slide reproduced in Fig. 2, in which the equivalent static pressure on the surface of the system, indicated by the dotted lines, could be seen to increase as the natural period of the system rose to about 30 cycles per second; the static pressure then actually decreased until a natural frequency of 45 cycles was reached, when it slowly rose again. The static suction, indicated by the full lines, was more regular in its development. Usually, the lecturer said, the fracture which resulted from high blast pressures started near one corner of the window and followed lines of high-frequency vibration in the neighbourhood of the frame, with the result that the central area, where the natural frequency of vibration was lower, was blown out in a few large pieces.

The behaviour of deep explosive charges was also of considerable interest. It was known, of course, that the resulting earth wave caused displacement mainly in a lateral direction at a distance from the actual crater. Near the seat of an explosion, blocks of concrete weighing many tons had sometimes been forced apart to varying degrees, though not lifted to any extent. The mechanical conditions that appeared to hold was that the excess pressure of impact bore such a relation to the number obtained by multiplying the distance and the cube root of the weight of the charge, that if this number were plotted against the excess pressure, the resulting curve approximated to a rectangular hyperbola.

It was also noteworthy that the penetration of elastic materials by bomb fragments was not directly proportional to the speed of impact. The curve of penetration plotted against speed arched up to a maximum corresponding to the elastic limit and then fell off. There might be a reflected wave of elastic compression which might even be able to expel the missile back along its original path. A common result of this elastic compression was also to cause a local disintegration at the surface opposite to the point of impact; the loose material then projected onwards and penetration was assisted by the resultant reduction in thickness.

Fig. 1.

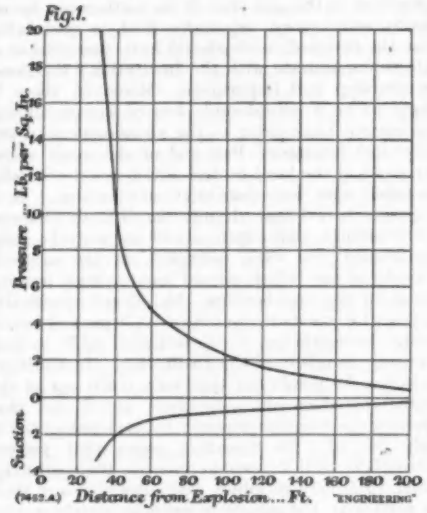


Fig. 2.

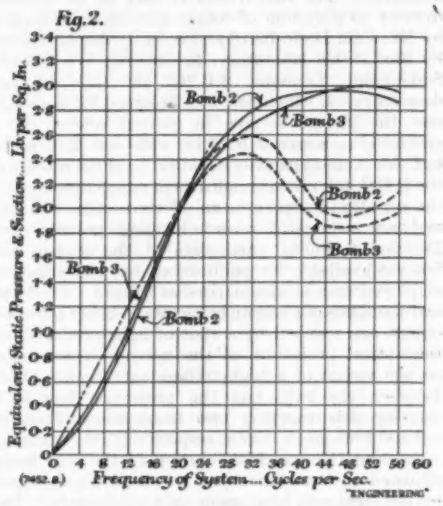

Equivalent Static Pressure & Suction ... Lb. per Sq. In.
Bomb 2
Bomb 3
Bomb 2
Bomb 3
Bomb 3
Bomb 2
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60
Frequency of System ... Cycles per Sec.
"ENGINEERING"

Fig. 3.

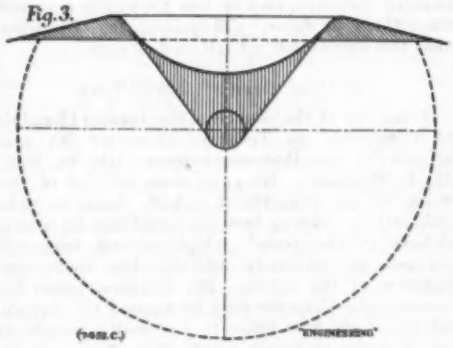
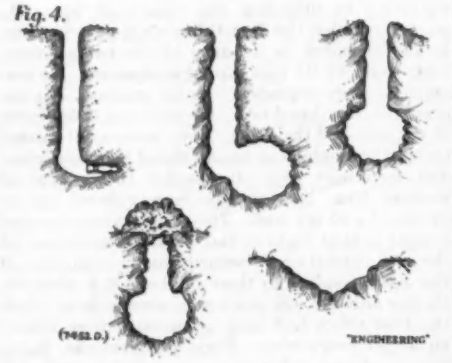


Fig. 4.



The majority of bomb fragments seemed to have sheared at an angle of 45 deg. to the outer surface. The speed of such missiles might be about 4,000 ft. per second. The slide reproduced in Fig. 3 illustrated the form of a crater resulting from the explosion of a buried charge, and in this diagram the vertically shaded portion was the part filled up by loose material after the initial explosion had subsided. The forms of craters produced by bombs dropped from high altitudes were shown by the slide reproduced in Fig. 4.

LETTER TO THE EDITOR.

FIFTY YEARS OF PRESSURE-SCAVENGING.

TO THE EDITOR OF ENGINEERING.

SIR,—I have naturally been greatly interested in the further correspondence under the above heading between Mr. Jackson and Mr. Yeates. The remarks in my original article were prompted, as I stated at the time, by what seemed to me to be unprecedented statements in recent commercial literature, which, to my mind, were to be deplored. The ensuing correspondence has made it clear that unqualified generalisations when closely examined are sometimes unjustified.

There would, I feel sure, be agreement between rival protagonists on the fact that the rate of fuel consumption is not, after all, the only consideration of a discriminating purchaser. The difference of a numeral in the second or third place of decimals when this is expressed in terms of lb. per brake horse-power per hour is not the deciding factor, but only one of the items in the cost of power generation. A true picture of relative merits in competing systems of pressure-charging can only be obtained by taking into account the costs of running repairs, cost of maintenance, the duration of stoppages for essential periodical overhauls as well as general reliability.

I am gratified to realise that the comments made in my original contribution have not been proved untenable.

Yours truly,
W. A. TOOKEY.

83, Cumberland-road,
Bromley, Kent. December 14, 1940.

CANADIAN COLLIERY INDUSTRY.—The production of coal in Canadian collieries, during the first eight months of the present year, amounted to 10,800,000 tons, against 9,200,000 tons in the corresponding period of 1939.

THE LATE SIR HARLEY DALRYMPLE-HAY.

SIR HARLEY H. DALRYMPLE-HAY, whose death, we regret to record, occurred at Chorley Wood, Hertfordshire, on Tuesday, December 17, at the age of seventy-nine, was intimately connected at the beginning of his career with the construction of more than one of London's tube railways. This connection he maintained throughout his life and, in recent years, was responsible for many of those important works of reconstruction which were necessitated by the increasing traffic of the metropolis.

Harley Hugh Dalrymple-Hay was born in India on October 6, 1861, being the son of Colonel James Dalrymple-Hay, of the Bengal Staff Corps. He was educated privately in Edinburgh and by Army tutors, being originally intended for a military career. It was decided, however, that he should become a civil engineer. He was, therefore, articled as pupil to the chief engineer of the Midland Railway and was engaged on the construction of certain lines in South Wales. At the conclusion of this work he obtained an appointment in the drawing office of the London and South Western Railway, and, in 1894, was appointed resident engineer for the Waterloo and City Railway, thus beginning his long connection with the "tube" type of railway construction. This line, which was a subsidiary of the London and South Western Railway, was built to provide better facilities between Waterloo and the city for the large number of suburban passengers using the main-line terminus. It was constructed from a working shaft sunk in the Thames near the Surrey shore a little to the west of Blackfriars Bridge, whence the two iron tube tunnels were driven both towards the city and towards Waterloo. Generally speaking, the stratum encountered was London clay and driving was effected without difficulty, but near Blackfriars and under Stamford-street on the Surrey side, compressed air had to be used. For this part of the work Dalrymple-Hay invented a hooded shield and clay pocket system of tunnelling, which was an improvement on the original shield that had been devised by W. F. Galbraith for driving tunnels under compressed air through water-bearing strata without causing subsidence of the ground above and without requiring the employment of a heading or timbers outside the shield.

The experience gained by Dalrymple-Hay on the Waterloo and City Railway was subsequently utilised in the construction of the Bakerloo, Hampstead and Piccadilly tube railways, which were opened for traffic at various times during the early years of the present century and now form integral parts of London's underground railway system. Under the conditions present, this work was mainly of a straightforward character and does not call for detailed comment. Mention may, however, be made of one special piece of work with which Dalrymple-Hay was connected. This, though a tube railway, was distinguished by the fact that it was intended for the carriage of parcels rather than passengers. The line was planned by the Post Office to run from the Paddington railway station and District Post Office in the west to the Eastern District Post Office in the east, connecting on the way with the Western Parcels, Western District and Western Central District post offices, the Mount Pleasant sorting office, the General Post Office at King Edward Building, and the railway station at Liverpool-street. The total length was 6½ miles, and the civil engineering work in connection with it was begun in 1914. Tunnelling was practically completed in 1917, but further work was then delayed until after the war, so that the railway was not actually opened until 1928. The construction was interesting from the fact that a single tunnel 9 ft. in diameter was used to carry two 2-ft. gauge tracks, while at the stations this was enlarged to a diameter of 25 ft. to contain three tracks and the platforms. The connection between the two different diameters of tunnels was made by an ingenious step-plate construction. A good deal of the excavation had to be done under compressed air owing to the presence of unusual geological conditions, and in one place a considerable subsidence occurred, which had to be dealt with.

Shortly after the conclusion of the 1914-18 war, it became evident that the surface works of many of the then existing stations on the tube railways required reconstruction. This was partly due to poor siting and inconvenient layout, but the main cause was the very large increase in traffic that had occurred owing to the extension of the Underground system into outlying districts. An extensive programme of station reconstruction was undertaken, therefore, the designs for which were prepared by Dalrymple-Hay and carried out under his supervision. Generally speaking, these included the replacement of lifts by escalators and the building of shallow-level circulating areas, but this by no means indicates the vast amount of detailed improvement which was effected. One of the most notable, as it was one of the earliest, of these reconstructions was that at Piccadilly Circus. At this important traffic centre, there was originally a small surface booking hall, access to which was only possible through three narrow entrances. As the station was even then used by some 25,000,000 passengers per annum, the congestion was frequently severe. The bold plan of reconstruction designed by Dalrymple-Hay swept away the old station and replaced it by a shallow-level circulating area under the Circus itself, to which access was obtained from the street by a number of short staircases. This work necessitated the diversion of several large sewers, as well as electric, gas and water services, and the laying of an extensive steel grid, which both carried the roadway and formed the roof of the circulating area.

Similar work was carried out at a number of other stations, including Waterloo, where he had to underpin the brick arches on which the main-line station is built; and at Leicester Square, where, though the design was similar to that at Piccadilly Circus, matters were complicated by the existence of a large open space in the roadway and the consequent presence of a large number of house sewers, pipes and cables, all of which had to be diverted from the site of the station. At a later date, Dalrymple-Hay was responsible for the reconstruction of the Tube railway stations at King's Cross, where, in addition to the difficulties we have just mentioned, the presence of the Fleet River, which at this point is carried in a brick conduit just above the line of the upper escalator tunnel, the proximity of

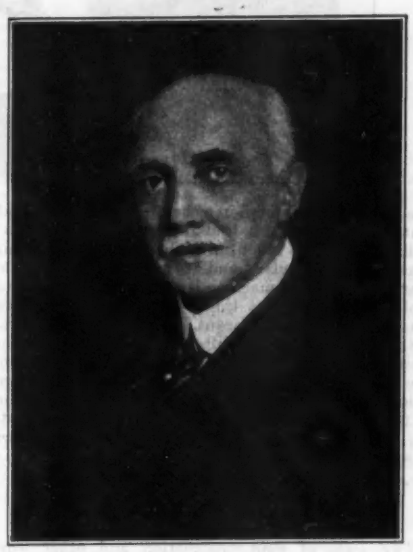


Photo: Elliott and Fry.

THE LATE SIR HARLEY DALRYMPLE-HAY.

the main-line stations, and the awkward arrangement of the inter-connecting passages at the running platform level gave rise to special difficulties. More recently he was responsible for carrying out the extension of the Bakerloo Railway from Baker-street to join the Metropolitan Railway at Finchley-road, and here again the presence of house property at the northern end of the line, and the gradual rise of the tracks almost to street level, added to the complications of the work.

Though, as will be seen, most of Dalrymple-Hay's work was connected with the London underground railways, in 1921 he was asked to report on a system of tube railways for Calcutta and a few years later planned a tunnel under the Hooghly to carry the cables of the Calcutta Electric Supply Corporation to Howrah. This tunnel, which is 573 ft. long, was completed in 1931. It was the first shield-driven iron-lined tunnel made under a great tidal river in the East, and its construction was rendered more difficult by the local climatic conditions and by the fact that most of the labour available was unskilled. About the same time, he was responsible for the construction of an extensive circulating water system at the Portishead generating station of the Bristol Corporation. This included two 7 ft. 6 in. culverts, which were driven for some 8,300 ft. under a cliff between the River Severn and the power station.

Dalrymple-Hay received the honour of knighthood in 1933. He was elected an associate-member of the Institution of Civil Engineers in 1887 and transferred to the class of member in 1899. He was serving on the Council at the time of his death. He had contributed a number of papers to the proceedings, and was the recipient of the Telford Medal and Premium, and of the Miller Prize.

THE LATE MR. HENRY J. SPOONER.

MANY thousands of former students of the Polytechnic School of Engineering, Regent-street, London, will share our regret at the death of Mr. Henry J. Spooner, for 40 years head of that department of the Polytechnic. Mr. Spooner, who was in his 85th year, retired in 1922, but continued to take a keen interest in many branches of engineering and kindred subjects. Noise, its ill effects, and the possibility of its diminution in everyday life, was a special study of his later years; but he was a man of unusually wide interests, as his books, lectures, and letters to the Press demonstrated.

Henry John Spooner was the son of Henry C. Spooner, an engineering contractor, and was born on June 14, 1856. He was educated privately and at the Royal School of Mines, and afterwards was trained as a civil and mechanical engineer under Loftus Perkins, of high-pressure steam fame. Subsequently, he joined the technical staff of Messrs. Clark and Standfield, in which firm he was engaged in the design of floating docks and canal lifts. His connection with technical educational work began in 1879, when he undertook the delivery of a course of lectures to the employees of the Royal Small Arms Factory, Enfield, and the Waltham Abbey Powder Mills. These lectures were continued until 1887. In 1882, however, when still only 26 years of age, Spooner was appointed principal lecturer in mechanical science at the Polytechnic. For some years he was able to combine these duties with other lecture work, such as that at Enfield, and with various consulting activities; but, as the Polytechnic engineering school grew under his vigorous direction, he found less and less time for outside work other than the participation in educational and similar conferences which his position made necessary. He was actively engaged, also, with the writing of a number of text-books, of which *Machine Design, Construction and Drawing* is probably the best known. Others dealt with geometry and geometrical drawing, steam, and motoring—he organised pioneer instructional courses in motor engineering as long ago as 1896, and similar courses in aeronautical engineering in 1908—and most of them bore evidence, especially in the notes, of his own breadth of interest. This trait was well exemplified by the annual list of notable anniversaries which he had contributed, since his retirement, to *The Observer*.

Mr. Spooner took out a number of patents for steam plant, including one, at least, for a combined steam and internal-combustion engine, and others for the preparation of peat as fuel, and for various anti-noise devices. During the war of 1914-18, some 2,000 munition workers were trained under his supervision, and he served also as honorary technical adviser to the King George military hospital and to the Union of South Africa in connection with vocational work at the Union's military hospital in Richmond Park. He had been a member of the American International Committee on Industrial Fatigue since 1912, but it was only in 1917 that he became generally known in this country in this connection, by the delivery of a Chadwick Lecture on "Fatigue and the Worker," at the Gretna Green munition factory. He continued his campaign against noise after the war, with a paper on "Fatigue Due to Noise and Methods of Elimination," delivered in Milwaukee in 1921 before the American Society of Industrial Engineers, and a further Chadwick Lecture in Blackburn in the same year. Scientific management was another subject to which he devoted much attention, and he was on terms of close personal friendship with Dr. Francis Gilbreth and other workers in this field; he also lectured extensively on fuel economy and on the prevention of waste and the utilisation of waste products.

Professor Spooner—to give him the courtesy designation by which he was generally known (except to his students, who usually alluded to him as "Henry J.")—joined the Institution of Mechanical Engineers as a graduate in 1883, and became a member three years later. His connection with the Institution of Civil Engineers was almost as long, for he was elected associate-member in 1885. He was also a Fellow of the Royal Meteorological Society and of the Royal Astronomical Society, a member of the Institution of Automobile Engineers, and an honorary member of the Junior Institution of Engineers. He was also a member of various French and American societies of like interests. Foreign recognition of his work included the distinctions of Knight Commander of the Royal Order of St. Sava, conferred on him in 1895 by King Alexander of Serbia, and Knight of the Golden Cross, Royal Order of the Redeemer, conferred by King George of Greece in 1907.

WIRE BUTT-WELDING MACHINE.

The process of resistance butt welding, or slow butt-welding, as it is sometimes called, depends on the local generation of heat by a current in two pieces of metal which have been brought into end-on contact. A machine for this purpose must enable the parts to be welded to be clamped accurately in line and must have means for supplying current and producing the necessary pressure, so that the parts may be kept in contact during the heating period and "pushed up" to form the weld. It is desirable that the parts to be welded should be of fairly regular section and should have square-cut ends so that they make reasonably good contact over the whole surface. Under these conditions, the welding will take place evenly over the joint when the latter is raised to the appropriate temperature, while the pressure, which pushes one section into contact with the other, squeezes out the undesirable oxide. Naturally, the slow butt-welding process is more suited to certain classes of work and material than others; and while it is difficult to give a general classification, it may be said that it is used almost exclusively for non-ferrous metals of all sections, though, as regards steel, it is, as a rule, limited to sections below ¼ in. square. The factors which govern the quality of the weld, providing the material is weldable, are the current, upset pressure, and point of current cut-off, and these variables must be adjusted to give the best results. Since the effect of heating a carbon-steel above the upper critical temperature and then cooling it rapidly, which occurs in the welder, is to produce local hardening, it is often advisable to anneal the joint. Since this operation can be conveniently done electrically, the machine should be provided with the necessary equipment.

The accompanying illustration shows a machine which has been constructed by Messrs. The Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, for carrying out the butt-welding process, which has just been described. It was primarily designed for welding wires of various sizes, but, with slight modification to the welding jaws, it can be adapted to other shapes of material having about the same cross-sectional area. The standard machine, which is fitted with standard jaws, is suitable for welding mild steel and high-carbon steel wire from No. 20 S.W.G. to No. 4 S.W.G., copper and bronze wire from No. 20 S.W.G. to No. 8 S.W.G., and aluminium wire from No. 20 S.W.G. to No. 8 S.W.G. The machine is rated at 2·5 kVA and is about 3 ft. 6 in. in height.

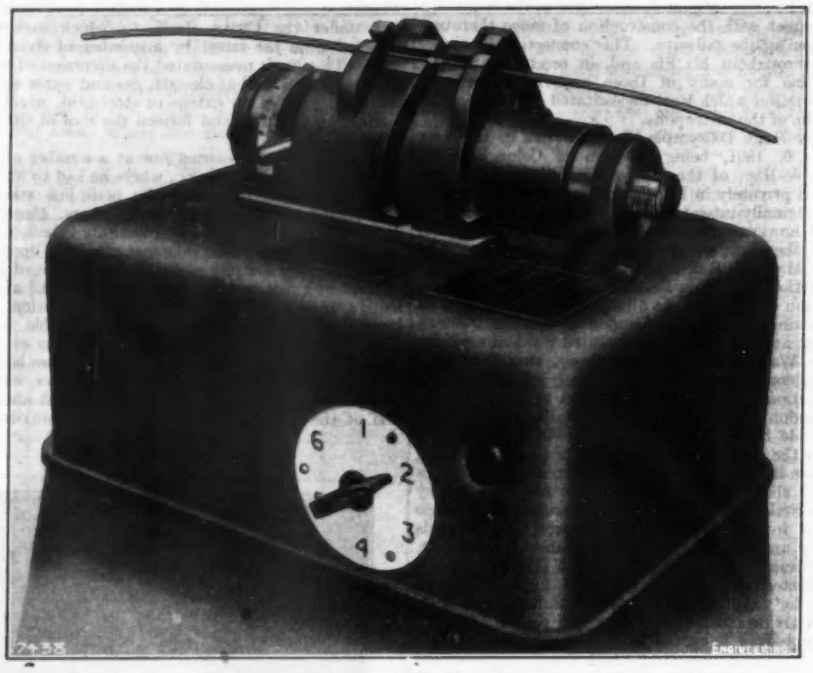
The close-up view of the top of the machine, which we reproduce, shows that the jaws for holding the parts comprise a fixed and a movable member. The movable member opens against the pressure of a spring and is operated by a pedal which projects from the base of the machine. The jaws are provided with V-grooves of different sizes to fit the various gauges of wire so that the pieces to be worked can be readily aligned in the full view of the operator. The amount of "push-up" required for any weld can be adjusted by moving a lever on the left-hand side of the machine. This lever controls the movement of a specially-designed internal cam, which accurately sets the position of the sliding platen carrying the right-hand jaws. A graduated scale provides the necessary means for ensuring the exact repetition of any established set of welding conditions. The pressure between the parts to be welded is provided by a helical spring, which is mounted inside the machine and presses against the moving platen, thus forcing it towards the fixed platen. The spring pressure is adjustable by means of a knurled thumb nut on the extreme right of the machines, and pressures from 5 lb. to 25 lb. per square inch are obtainable. A graduated scale on the thumb nut enables pressure settings to be made rapidly.

The rotary current-selector switch visible on the front vertical face of the machine enables six different current settings to be obtained. The current cut-off switch is housed just below the name plate on the top base of the machine and the point of cut-off is adjustable. When once it has been set, the operation is automatic. The push-button visible on the right of the current selector switch is for initiating the weld. When the work has been clamped in the machine jaws and the current and pressure have been set the initiating push button is depressed and if held in that position the weld will be automatically completed. On the other hand, if the push button is released at any point during welding the operation will cease at that point.

At the front of the main jaws are a pair of annealing jaws, so that the work, after having been welded, can be withdrawn into them and annealed if necessary. The graduated scales for push-up and pressure and also the current tapping positions are all arbitrary and a table of settings for the different materials—mild steel, high-carbon steel, copper and aluminium—is fixed on the top of the machine. This arrangement of settings, it is claimed, obviates complicated scales which might cause trouble to an inexperienced operator.

2·5-KVA WIRE BUTT-WELDING MACHINE.

MESSRS. METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, MANCHESTER.



The machine is mounted in a sheet-steel case and is self-contained. The supply leads, which are formed into a trailing cable, are taken in at the rear of the machine through a Wylex gland and are attached to a terminal board inside. The machine is provided with a pair of rubber-tyred rollers at the rear of the base. It can thus be tilted back by means of a hand rail at the rear so that the front feet are lifted off the floor and in that position it can be wheeled to any convenient position. The machine thus lends itself to quick and easy manipulation and the various adjustments necessary for setting up the work, it is pointed out, are such that the operator has only to concentrate on one action in the process at a time.

SPOIL-MOVING EQUIPMENT.

The scale of road-construction and other works involving the movement of large quantities of spoil in the United States has given an impetus to the development of equipment specially adapted for rapid handling of the material in bulk, some of which equipment has been described in these columns from time to time. These accounts may be supplemented by some notes on the latest practice, particularly since the machines in question are now being manufactured in Great Britain by Messrs. Ruston-Bucyrus, Limited, Lincoln. Two new four-wheel scrapers have been introduced, viz., one of 6-cub. yd. and the other of 8-cub. yd. capacity. The scrapers were originally designed by Messrs. Bucyrus-Erie Company in collaboration with Messrs. International Harvester Company, both these firms, as is well known, operating in the United States.

The scrapers have only five main parts, viz., the tongue assembly, a frame with side plates, an apron, a tilting bowl and the rear-axle assembly. Operation is by means of cables from the towing tractor, one cable regulating the height of the cutting edge and the other controlling the opening of the apron and the tilting of the bowl. When the load is to be dumped, the bowl is tilted into an almost vertical position, which gives positive controlled rolling ejection. The bowl is a reinforced plate presenting a curved surface, both below and behind the spoil heap. It rotates between the fixed side plates of the frame, but its front edge is hinged to the frame, just behind the cutting blade, by means of a bar extending for the full width. As the bowl rotates about this hinge in dumping, the bottom is lifted and the spoil is ejected with the rolling motion referred to above, the operation being aided by gravity. Adhesion of the spoil is virtually eliminated by the high angle to which the bottom of the bowl is lifted and by its scraping action against the frame side plates, which close the gap at the sides between the bowl and apron in all positions. It is claimed that the new construction, which has been fully tested in this country, reduces the tractor horse-power required for loading and materially increases both the speed and the ease of making a loading cut. It also permits a wide wheel spread and low centre of gravity, which make for stability in loading and dumping, particularly in such circumstances as the finishing of side slopes. Special care has been taken to ensure long life of the operating cables, by the provision and disposition of large interchangeable sheaves mounted on roller bearings. Hauling of the loaded scraper is facilitated by the constant wheelbase, which maintains an even distribution of the load. It is claimed that time is saved on each journey by the short non-stop turns possible.

Other recent machines include improved bullgraders and bulldozers, of which four sizes are made to work, like the scrapers, in conjunction with International Harvester tractors. The blade of the bullgrader or bulldozer is curved so as to roll the spoil along instead of pushing it, thus reducing fuel consumption in the tractor. The bullgrader blade can be set at an angle within a few minutes by one man without the use of either jacks or a heavy sledge hammer. The blade is constructed of manganese-steel plate and the cutting edges for each side and the bottom are replaceable. Operation of the blade is hydraulic, two cylinders being provided controlled by a valve with four positions, viz., raise, hold, lower and float. The oil pressure is between 225 lb. and 250 lb. per square inch in normal operation, and the employment of this comparatively low pressure is stated to avoid excessive heating, with the result that ordinary qualities of oil can be employed. At the same time, a relief valve set for a maximum pressure of 350 lb. per square inch, incorporated in the control valve, enables higher pressures to be used to meet exceptional conditions of short duration.

The frame is of welded steel of heavy box-section and is designed to withstand shock loads from either side, as well as from top to bottom. It transmits the load to the tractor at two points, so that side stresses are not imposed on the tractor track frames, which take the weight of the pushed machine; no rubbing plates have been found necessary. The connection between the hydraulic cylinders and the blade through the lift arms and main frame of the machine is particularly rigid to avoid the chatter often experienced in bull-graders. The lifting mechanism is independently arranged on each side, so that there is no tendency towards distortion from track oscillation, while the blade can be held level relatively to the surface of the ground, within the limits of the piston travel in the cylinders, regardless of the oscillation of the tracks. Ball and socket type couplings are employed with removable shims for adjustment for wear, a form of connection which is both positive and automatically-adaptable to meet small misalignments. The bull-graders and bulldozers form a complete unit with the tractors and are designed so that the tractor driver can see the whole of the blade and the work it is doing from his normal position.

THE USE OF DIESEL ENGINES IN MINES.

INTEREST in the possibility of using Diesel engines for haulage purposes in mining and tunnelling has been increasing recently in the United States, largely as a result of the reported successful use of Diesel locomotives in European coal mines and the development of suitable engines of this type in America. The Bureau of Mines, of the United States Department of the Interior, has therefore undertaken an investigation of the possible hazards involved in their use underground, the results of which have been summarised in a paper by Messrs. H. H. Schrenk and L. B. Berger, chief chemist and associate chemist, respectively, in the Health Division of the Bureau.

The arguments adduced in favour of the application of the Diesel engine to underground haulage have been based, for the most part, on comparisons with the petrol engine, the claims for its superior safety emphasising more especially the lower carbon-monoxide content in the exhaust gases and the reduction of fire and explosion hazards on account of the low volatility of the fuel. In these respects, the heavy-oil engine offers definite advantages over the petrol engine, the use of which in underground service has always been discouraged by the Bureau of Mines. It appears, however, from European experience, that there are still certain hazards accompanying the employment of Diesel engines underground, and it was for the purpose of obtaining first-hand information regarding these that the Bureau undertook their investigation.

The main phase of the study, so far, has dealt with the composition of the exhaust gases. Knowledge on this point was not only essential to the safe use of Diesel engines in confined spaces, but was also expected to prove of value in establishing a basis for the ventilation of vehicular tunnels in general. The results of the study to date, it is stated, have shown that carbon monoxide, carbon dioxide, and oxides of nitrogen are present in concentrations that are considered harmful to breathe. Under some conditions, objectionable amounts of aldehyde, as well as of smoke, may be produced. The fuel-air ratio was found to have a marked effect on the production of carbon monoxide; but this, and the production of smoke, could be largely controlled by proper adjustment of the fuel-air ratio without any significant sacrifice of power output under full-throttle conditions.

The experiments demonstrated that adequate ventilation must be provided if the exhaust gases were discharged in underground working places; that, because of their toxic character, the carbon monoxide, carbon dioxide, oxides of nitrogen, and oxides of sulphur (if the fuel contained sulphur) in the exhaust were the constituents of chief significance in relation to ventilation; and that Diesel engines employed underground should not be operated at rich fuel-air ratios because, under this condition, the exhaust contained high concentrations of carbon monoxide and soot. The degree of ventilation required for Diesel engines in underground mine workings has been under consideration by the Bureau, according to the report, but it was felt that there were additional factors affecting the performance of the engines which must be investigated before any comprehensive recommendations could be formulated.

CHARTERED SURVEYORS' INSTITUTION.—The list of Prize winners at the 1940 professional examinations of the Chartered Surveyors' Institution has now been published. The Penfold Gold Medal and the Driver, John Gilchrist, Galsworthy and Mellersh Prizes have been awarded to Mr. R. A. Milligan; the Wainwright Prize to Mr. W. H. Rees; the Crawter Prize to Mr. L. P. Layton; the Beadel Prize to Mr. C. W. Bruce; the Hyman Marks Prize to Mr. John Foster; and the Julian Rogers Prize to Mr. J. P. T. Thomson. The "Quantities" Prize has been gained by Mr. J. A. Hitchcock; the "Constructive and Working-Drawings" Prize by Mr. R. J. Matson; and the Institution Prize by Mr. J. J. F. Kemp.

GAS FILLING STATIONS FOR MOTOR TRANSPORT.—A useful service to the owners of motor vehicles has been done by the British Commercial Gas Association in publishing a list of existing filling stations at which the low-pressure gas bags carried by gas-driven vehicles may be recharged. This list, *Gas Filling Stations for Motor Transport*, contains particulars of some 430 stations, in England and Wales and Scotland, either at garages or on the premises of gas undertakings. The stations are conveniently grouped under county headings in alphabetical order and, in many cases, the hours of business are given. Blank pages are left for additional entries, but, as the number of stations grows, revised lists will be issued. Copies of the pamphlet may be obtained, price 2*d.* each, from the Association, Gas Industry House, 1, Grosvenor-place, London, S.W.1.

LABOUR NOTES.

IN the House of Commons on Thursday last week, Mr. Thurtle, the Labour Member for Shoreditch, asked the Minister of Labour and National Service if he was aware that unofficial strikes were being promoted in munition factories by shop stewards who were working in the interest of a political party which was seeking to obstruct the national war effort, and if he would state what action he was taking in the matter. In reply, Mr. Bevin said that he regretted that stoppages of work had taken place in breach of the agreed procedure for dealing with disputes and before the constitutional authorities had had an opportunity of discussing the matters in dispute. Having regard to the persons concerned, and the published statements, he could not avoid the conclusion that in certain cases the stoppages had been caused as part of a settled policy. As recognised trade union representatives, it was the duty of shop stewards to act in accordance with agreements to which their organisations were parties, and he felt sure that the cases to which he had referred would receive consideration by the executives of the trade unions concerned. So far, he had refrained from taking legal proceedings as he was convinced that it was the desire, as it was within the powers, of the trade unions to take such steps as would maintain constitutional procedure and that in such action they would be supported by the general body of their members. It was, however, Mr. Bevin said, his considered view that, in order to avoid conditions which caused discontent, there should be set up in all industrial establishments standing joint arrangements for regular discussion between managements and properly-elected representatives of the workpeople of matters in which they were mutually interested. The time lost during recent months as a result of disputes had been exceedingly small, and having regard to the abnormal circumstances, the general position was such as to give renewed confidence in the operations of voluntary joint collective machinery supplemented, as it now was, by the provisions of the Conditions of Employment and National Arbitration Order.

Mr. Thurtle asked the Minister to bear in mind that the people resented these Communist efforts to let down our fighting men, and not forget that these very people who were now seeking to hamper us in our fight against Hitlerism were, before the war, loudest in their demand that Hitlerism should be smashed. Mr. Bevin replied that he would bear the points in mind. "But," he added, "I also have to have regard to the fact that, if legal repression is applied too readily without utilising what is the most powerful force in this or any other country—the voluntary discipline of the organised bodies—I might create a worse condition than I seek to remedy."

Mr. Hopkinson, Independent Member for Mossley, asked if it was not a fact that during a period of vastly inflated wage rates it was utterly impossible for the trade unions to keep control of the situation and the whole power evolved into the hands of the shop stewards. Mr. Bevin replied that he did not accept the view concerning inflated wage rates. Mr. Hopkinson, he said, could not have read the report on the returns from 60,000 firms which appeared in the December issue of the *Ministry of Labour Gazette*. Had he done so, the Minister observed, he would not have used the term "inflated." The increase in wage rates since the war was approximately 10 per cent., against a much higher cost of living, but, Mr. Bevin added, "I would emphasize the point that the more the men earn by way of bonus, which is based on increased output, the lower is the cost of production." Mr. Hopkinson said:—"I am perfectly well acquainted with the situation, and what the right hon. gentleman has said has given a totally wrong impression."

By regulations gazetted under the National Security Act, with the approval of the Advisory War Council, the Australian Commonwealth Government assumes the power to deal with inter-State industrial disputes, thus over-riding the provision in the Constitution limiting the Commonwealth's powers of conciliation and arbitration to the prevention and settlement of inter-State disputes. The regulations, the Canberra correspondent of *The Times* says, overcome for the duration of the war what has been considered an outstanding weakness in the Commonwealth industrial arbitration system, and immensely extend the powers of the Commonwealth Arbitration Court.

When the Commonwealth Government tried to procure these powers by popular referendum in 1911, they were, the correspondent says, decisively rebuffed. Mr. Bruce proposed, in 1929, that the Commonwealth should withdraw from the field of industrial arbitration owing to the constitutional limitation which has now been abrogated, but his Government were overwhelmingly defeated and he lost his seat. Nevertheless, it is recognised that the urgent necessity for a speedy settlement of industrial disputes in war-time demands the strengthening of the powers of the Commonwealth, particularly as the Commonwealth Government themselves are the largest employers of labour in the war services. The regulations dispense with formalities likely to delay the hearing of disputes and grievances and empower the Court to make its award a common rule for the industry concerned, instead of limiting its application to the employers and members of the trade unions cited before the tribunal as heretofore. As was the case during the last war, the correspondent adds, a considerable enlargement of the Commonwealth's powers at the expense of the States is inevitable.

An award of the Industrial Court is to the effect that the painters' rate in the Aldershot district is 1*s.* 8*d.* an hour. A provision of the National Arbitration Order, it will be recalled, is that terms of employment negotiated by representative organisations in an industry must be observed by all employers. The employers in this instance argued that as they were not members of the National Joint Council they were not bound by its decision to increase the painters' rate from 1*s.* 6*d.* to 1*s.* 8*d.* an hour. The opposite view was taken by the National Federation of Building Trades Operatives, whose claim the Industrial Court has now endorsed.

At a meeting in London last week, representatives of the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Railway Clerks' Association, submitted to representatives of the Railway Executive Committee arguments in support of their claim for increases of wages. The representatives of the companies promised to give the statements careful consideration and to reply to them at as early a date as possible. The claim of the unions is for a 10*s.* a week advance in the adult male rates of the traffic grades and one of 26*l.* a year in the wages of the clerical and supervisory staffs, with proportionate increases for women and juniors.

On behalf of women doing men's work in the engineering industry, the National Union of General and Municipal Workers and the Transport and General Workers' Union have submitted a claim for a substantial increase of wages—it is said to be 5*s.* a week—to the Engineering and Allied Employers' National Federation. The application was discussed at a meeting in London last week with representatives of the federation and, speaking for the employers, Sir Alexander Ramsay promised that the arguments submitted would be considered and a reply given at a further meeting next month.

The Ministry of Labour and National Service announces that at November 30 the official cost of living figure was 95 points above the level of July, 1914, compared with 92 points at November 1. The rise of three points from 192 to 195 (the figure for July, 1914, being 100) is equivalent to about 1½ per cent. For food alone, the index figure at November 30 was 73 points above the level of July, 1914. This was one point above the figure for November 1, the rise being largely due to increases in the prices of some kinds of fish. Among items other than food there were increases, averaging about 5 per cent., in the prices of clothing (including clothing materials), partly due to the operation of the purchase tax. There were also increases in the prices of coal in many districts. Since October 21, when the purchase tax came into operation, increases in prices resulting from the tax have raised the cost of living index figure by between 1½ and 2 points.

A Spanish Order issued in June last provides that, for workers of all classes employed in coal mines, wages are to be calculated on the basis of a seven-day period including Sunday or the weekly rest day as a paid day. This provision does not apply to casual workers whose wages are, however, increased by 15 per cent. The Order also provides that in view of existing necessities and, with the approval of the ecclesiastical authorities, Sunday work may be temporarily authorised in coal mines subject to the condition that the workers receive a compensatory rest day and one free hour on Sundays to enable them to perform their religious duties. If, in cases where it is impossible to organise work in rotation, a miner works all seven days of the week without obtaining a day of rest in the course of the following week, work performed on Sunday has to be paid for at 40 per cent. above normal rates.

PROGRESS IN THE DESIGN OF MINING ELECTRICAL EQUIPMENT.

Some changes in the design of electrical control equipment for use in mines were discussed in an address prepared for delivery to the London Branch of the Association of Mining Electrical Engineers, by Mr. N. V. Castling. While the outward appearance of metal-clad switchgear, Mr. Castling said, had not altered very much, there had been a few radical modifications owing to the adoption of small oil-volume and air-blast principles at certain voltages. It was not yet certain whether the advantages of these in design and performance would justify their adoption, and for pressures below 33 kV the present standard patterns would hold their own for some time to come. In mines, the tendency was to use air-insulated control gear on medium-voltage systems in-bye, owing to ease of maintenance and the convenience with which isolators and other protective fittings could be added.

Malleable-iron or gunmetal dividing boxes were being favoured instead of cast-iron on mining switchgear, particularly for boxes that could also be used as straight-through junction boxes, the object being to prevent accidents due to fracture of the enclosure. Ease in making and breaking cable-box joints was a most important consideration to the user, and standard cable boxes should be suitable for fixing at several angles. The series over-current coil was still widely used for the protection of mining apparatus and to obtain the best operating conditions a suitable time-lag device should be fitted. Plug interlocking was usually provided by a mechanical attachment to the circuit breaker. That did not prevent the removal of the plug at the feeder end, and it was becoming more common to provide an electrical interlock at both ends, thus necessitating the use of a five-core instead of a four-core cable. The pilot circuit for the remote control of conveyors and coal cutters necessitated special consideration. It should be intrinsically safe and be so arranged that it opened the main circuit in the event of a short-circuit of the pilot wires in any place other than the pilot switch.

Modern 33-kV metal-clad substations included oil-immersed isolators in a totally-enclosed metal-clad structure. The result was a considerable reduction in overall dimensions as compared with the open type, and several other novel operational and constructional features. The panels could be erected in a single row or in two parallel rows according to the existing site conditions. In either arrangement, the 'bus bar ring was completed by means of cable connections. The six-position 'bus-bar selector enabled each individual circuit to be fed from the 'bus-bar sections on both sides, or from either side, and also permitted the complete isolation of the circuit from the 'bus bars for maintenance without interrupting the 'bus-bar ring or interfering with the service of adjacent panels. The circuit breaker was arranged for remote control and was of the non draw-out pattern. Its position, however, enabled the tank to be lowered, and the fully-interlocked earthing and isolating switches allowed maintenance operations to be performed in complete safety. All the earthing and isolating switches were directly operated manually, at the mimic-diagram panel on the operating gallery, with full visual indication of the operation in progress, and the complete interlocking system ensured mistake-proof operation.

Development had been proceeding on the lines of reducing the oil contents of circuit breakers for pressures of 33 kV and above. Several types now on the market comprised three single-break single-phase units mounted on a steel framework and arranged for pneumatic operation. In the simplest form, no provision was made for current transformers within the circuit-breaker construction, but in others it was possible to accommodate either straight-through or Stabec insulated cascade-type current transformers. Separate current transformers were preferable, because they allowed any necessary modification to be made in the shortest possible time. Auxiliary switches were provided as required for indication, interlocking, or other purposes.

So far, air-blast circuit-breakers did not reach the same standard of safety as the small oil-volume type. Their operating parts were more numerous, and complicated, and, owing to the constant air supply, the circuit at light duty was broken at a forced zero, causing voltage rises and unnecessary stress on other parts of the network, particularly with overhead lines. The use of air as the insulating medium rendered the overall dimensions much larger than those of the small oil-volume type and they could not readily be adapted to metal-clad switchgear.

American Tin-Plate Industry.—The quantity of tin-plate exported from the United States of America during the first half of the current year totalled 264,549 tons, against only 98,956 tons in the first six months of 1939, and 89,227 tons in the first half of 1938.

VIBRATION PATTERNS OF PROPELLER BLADES.*

By Dr. G. S. Baker, O.B.E.

(*Concluded from page* 486.)

In the earlier part of the paper, the results were given of vibration tests carried out on seven cast-iron propellers, and the various types of resonance observed were severally discussed. A general diagram showing all the resonance frequencies below 7,500 cycles per second is given in Fig. 29, opposite.

To prevent any misunderstanding, it may be as well to state that the remarks and conclusions in the paper are concerned only with the effect of blade shape upon resonant vibration, and not at all with the changes produced by shape in the hydrodynamic forces on the blades. A few broad conclusions can be formed in regard to the vibration of flat propeller blades. It is quite clear that all low-frequency vibration of any kind on one blade sets up similar and nearly as noticeable vibration on the opposite blade, despite the use of cast iron with its high damping compared with bronze. With all the simple forms of resonance the motion was strong, there was a fairly wide latitude as regards the point of application of the exciting force which would produce the motion, and the vibration could be produced (with some loss of clarity) even with moderate error in frequency of force. With most high-frequency resonance the motion is small, the resultant pattern is always a mixture of two or more types of motion of different frequencies, and the nodal lines become closely spaced. The mixture of frequencies adds considerably to the internal damping of the motion. The close spacing of the nodal lines reduces the effect of a given exciting force. The cumulative effect of all these variations is that, at high frequencies, little vibration is found in the unexcited blade, except with the very unbalanced type E.2. The limiting frequency for effective locking across the boss was below 4,000 cycles per second for all but E.7, which showed some tip motion a little above this. Even with E.2, only one or two patterns could be made on the unexcited blade above 5,500 cycles per second. For all these reasons, the promotion of continuous vibration of the blades of a rotating propeller, receiving its excitation from a somewhat distributed hydrodynamic force, would become very difficult at frequencies above that corresponding to 4,000 cycles per second, and any audible note would vanish at and about this point, a conclusion which may explain the fact that few notes are heard above about 300 cycles per second on a normal single propeller.

Before these results can be applied to a ship propeller, the effect of the pitch of the blades must be considered. If one applies a straight-edge to the driving face of a propeller blade, it will be found possible to fit it to the face within narrow limits of error along two sets of lines. The first are the strickle lines, running radially from the boss with uniform pitch and no "wash back" of the surface, but always nearly radial even with pitch reduction or wash back. These are shown as lines A in Fig. 28, below, on two propellers, one of uniform pitch, the other with sections washed back towards each edge at the root. The second set run diagonally across the blades, nearly parallel to each other, as shown by the lines B in the figures. If the blade is very wide, as on a destroyer propeller, such straight lines as B are confined to the outer 10 per cent. of the blade, the surface having too much curvature near the boss. With a disc-area ratio of 0·6, and a maximum blade width a little less than the free length of blade, such lines can be found over the outer half of the blade. With a normal mercantile single-screw propeller of 0·45 to 0·4 disc-area ratio, the lines can be found over the majority of the blade. Pitch reduction at the boss increases this area a little, wash back of the driving face diminishes it. The inclination of lines B to the centre-line of the blade increases from about 45 deg. to 55 deg. as pitch ratio increases from 0·5 to 1·0. Shape of blade outline (for moderate disc-area ratios) has practically no effect on the slant of these lines, and Fig. 28 can be taken as representative of the majority of such screws.

On any straight line inclined to the radial line more than lines B, the driving face will be rounded or convex, and on straight lines more slanting than B, the driving face will be hollow. On these lines A and B, therefore, the blade section will have a minimum inertia for all flexural bending, and along these lines the blade section will be identical with those on a flat blade as in these tests, and the mass distribution about the lines will be reasonably the same. It is suggested, therefore, that, when the nodal lines of any resonance of a flat blade approach parallelism with these straight lines on the twisted blade of a propeller, the vibration will not be greatly affected by the pitch. Where, on the other hand, the nodal lines run counter to these straight lines, the increase in inertia due to the blade curvature will raise the frequency for this particular resonance, or stop resonance altogether. In any case, the extra stiffness will make the flat-blade results somewhat doubtful in applicability except as a general picture.

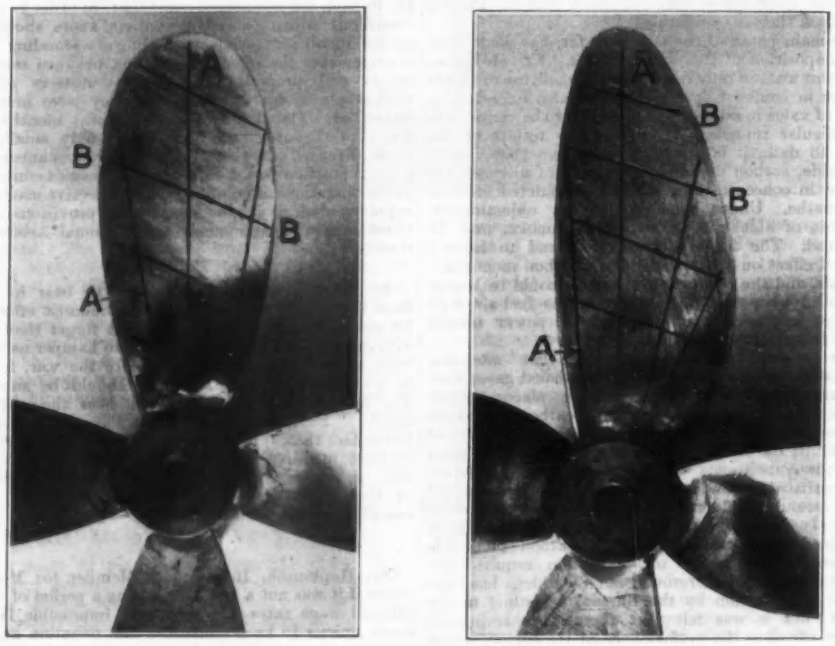


Fig. 28. Straight Lines on Face of Pitched Propeller.

The second effect of the pitch of the blades in a propeller is on the transfer of vibration from one blade to another on the same boss. These tests were made with two-bladed propellers, so that the mass effect of the unexcited blade should be taken into account; but, with flat blades, the roots of the blades are in the same plane, and the maximum transfer of vibration takes place. With a pitched blade, the roots of opposite blades are inclined at a considerable angle to each other and the transfer of vibration will be less easy; in other words, these results will show a better transmission across the boss than would be found in a true propeller.

Reviewing the results obtained in the light of the above remarks, some general conclusions can be

---

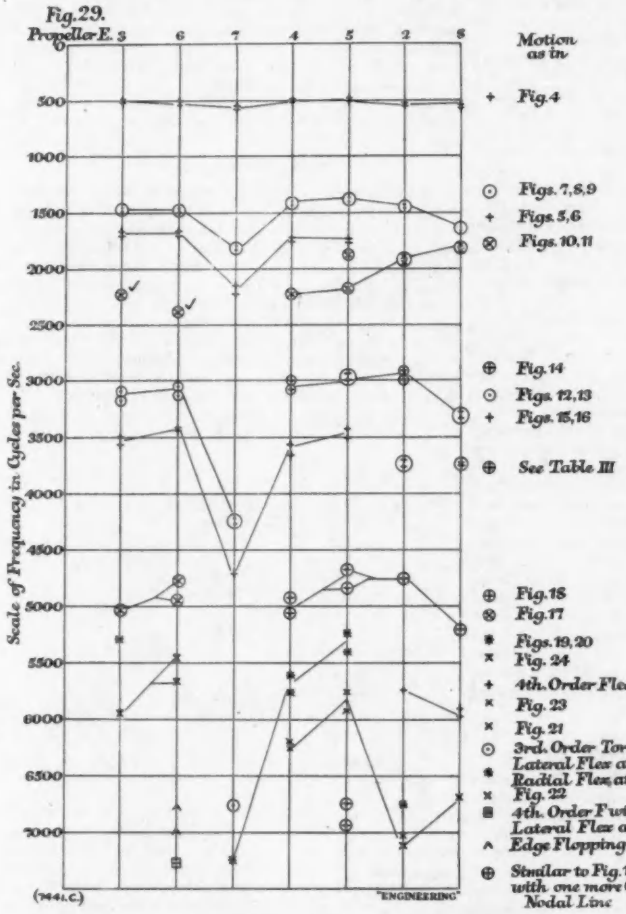
* Paper read before the North-East Coast Institution of Engineers and Shipbuilders at Newcastle-upon-Tyne, on Friday, November 15, 1940. Abridged.

formed. Near the blade root of a propeller a section of the blade by a plane perpendicular to its middle line would have a convex face; but, by turning the plane a little, most of this curvature can be taken out of the section, although some always remains. The root inertia will therefore be somewhat higher than for the flat blades, and the primary flexural resonance higher, and on a slightly different line. The primary torsional motion will hardly be interfered with by the pitch of the blades, and, with the symmetrical-outline blades, the nodal line will remain down the centre of the blade. With blades having the tips thrown back, or with rounded leading edge, the nodal lines obtained on E.4, E.5, and E.8 in these tests at 1,400 cycles to 1,600 cycles per second are reasonably close to radial lines of type A, and would be little changed by the twist of the blades.

Again, with second-order flexural motion on a twisted blade of symmetrical outline, the inertia of a section on a nodal line, shown by Fig. 5, *ante*, would be a little higher than on a flat blade and the frequency would be higher; on a blade of outline as E.4 and E.5, it would hardly be affected, as the nodal line lies nearly parallel to the lines B in Fig. 28, opposite. On practically all the propellers, third-order flexural motion has a nodal line more or less square across the blade, and this line would be quite hollow on a pitched blade. If this were found at all, therefore, it would be at a materially higher frequency and probably distorted by mixture with torsional motion. This also would be the case with the mixed motion occurring at about 3,000 cycles per second (Fig. 14). With unsymmetrical blades, the nodal lines on the outer half of the blade are seriously across the lines B of Fig. 28, and the inertia change on these lines would be considerable. This motion, therefore, would either not be present on a pitched blade or—like the third-degree flexural which occurs a little above it—will move to a higher frequency. This type of reasoning, applied to other higher resonances, shows that generally there would be an upward movement in the frequencies for any pattern on the pitched blade. This, however, does not apply with any weight to the lateral vibration given at the bottom of Table II, which would not change much.

Propellers E.3 and E.4 have circular back sections, and E.6 and E.5 differ from these simply in having aerofoil-section backs. In all cases, the blades have sharp edges. The figures and the tables of frequencies show that this change has made but very little difference in the resonance, either with the primary or secondary motion, these coming (in each pair) within 1 per cent. to 3 per cent. of each other. But blade outline has a most marked effect. The frequencies at which resonance occurs are not greatly affected for either first-, second- or third- order flexural motion, and even with the mixed torsional and flexural around 3,000 cycles per second, the effect upon the period is small. But the character of the nodal lines changes greatly, and, as the tip is moved back relative to the base, or as the centre of mass line is curved backwards, types of motion can be set up which can be more easily represented on a pitched blade and in which the flexural and torsional motion near the tip are very much alike in appearance. This is particularly noticeable on propeller E.2, on which the different modes of vibration were very clear and strong, suggestions that this propeller had overstepped the bounds of good practice in skew-back.

Fig. 29.



Type of motion indicated by Symbol Figure or Margin Note.
+ Radial Flexural. ⊙ Torsional. × Lateral Flexural. √ Indistinct.
Mixed Symbols indicate mixed vibration, torsion being always at the root, and lateral flexure at the tip, except at very high frequencies.

Thickening the blades has been tried in only one case, E.7 being the same as E.3, but with thicker sections. This thickening was carried right down to the root, so that, just clear of the fillet, the blade was 0·39 in. instead of 0·38 in. thick. This thickening moved the centre of gravity of a blade from 1·82 in. to 2·02 in. from the boss line. But the increased stiffness of all the inner part of the blade has a much greater effect than the movement of mass towards the tip, and the frequencies were raised by the change. This raising of frequency is also obtained in E.2 by the stiffer inner part of the blade, obtained in this case by the increased width of blade near the root.

A check upon the nature of the material used for the propellers was obtained, by making an additional propeller exactly similar to that considered by Mr. J. F. C. Conn. This was given a more solid boss than the others to ensure the maximum rigidity, since his calculation assumes a perfectly rigid root to the blades. The propeller was 1·0 ft. in diameter, with a boss diameter of 2·9 in., and a blade thickness of 0·335 in. maximum at the root, with circular back sections and parabolic outline. One blade was definitely harder than the other, and, in fact, this was noticeable on some of the other propellers, and may explain their differences. When vibrated, the primary flexural was 660 cycles to 710 cycles per second. Taking a mean 690, the value of E required to satisfy the equation on page 484 was $13 \cdot 7 \times 10^6$. The primary torsional frequencies were 3,440 and 3,540 and to satisfy the torsional equation on page 484, the value of N becomes $5 \cdot 95 \times 10^6$. Using the above values of E, the equation for primary flexural motion of propellers E.3, E.4, E 5 and E.6 becomes :—

$$\text{Frequency} = 0 \cdot 22 \frac{t_r}{l^2} \sqrt{\frac{g\,E}{\rho}}.$$

This fails to take account of the thickening of blades E.7, or the narrowness of the tips of blades E.2 and 8, and the parabolic propeller of Conn's. A more complicated formula which covers all of these with an accuracy of ±3 per cent. is as follows :—

$$\text{Frequency (c.p.s.)} = 0 \cdot 305 \frac{t_r}{l^2} \left(\frac{b_r}{b_m} \times \frac{t_m}{t_r} \right)^{\frac{1}{4}} \sqrt{\frac{g\,E}{\rho}},$$

where b_r and t_r are breadth and maximum thickness at root, and b_m and t_m are the mean breadths and mean maximum thickness of the blades, respectively. All dimensions are in inches.

The second-order and third-order flexural can be obtained by the use of the ratios given in Table II. These ratios are somewhat higher than the theoretical value given by Conn for his narrow-tip parabolic blade. A model of this propeller, but slightly thicker over the outer part of the blade, gave a ratio 3·1 against 2·6 for a blade, the thickness of which vanishes at the tip. This thickening of the blade raised the ratio on E.7 to 3·86 from 3·35 on E.3 with a normal thickness line, and possibly accounts for some of the above difference. The rest must lie in the method of calculation, mode of support of propeller, or the effect of the second and opposite blade. It should be added that a test was made on E.8 with a ¾-in. bolt through the 1¼-in. hole in the boss, but gripped tightly with nuts at the ends. The lower limit of the primary flexural remained the same as before. The upper limit was reduced 2 per cent. Changes of this order were found with other resonances, and an additional resonance (apparently flexural in type) at 1,400 cycles per second was found. Mode of support, therefore, can be left out of the above account.

The results are not sufficiently elaborate (or consistent) to allow of the framing of a simple formula for the primary torsional frequency. The following covers all the propellers used in these tests with an accuracy of ±5 per cent. :—Primary torsional frequency $= 0 \cdot 92 \left(\frac{t_h}{b_h l} \right) \left(\frac{b_r}{b_m} \right) \sqrt{\frac{g\,N}{\rho}}$, where b_h and t_h are breadth and maximum thickness, respectively, at half the free length l of blade. The constant 0·92 is based on an N value for cast iron of $6 \cdot 0 \times 10^6$, as found necessary with Conn's parabolic blade, to make the actual frequency agree with that calculated.

The formula can be regarded as useful only for the type of propeller blades tested, *i.e.*, with quite thin edges and rounded backs. Thickening of the edges would lower the constant, and some idea of this effect can be obtained from Conn's parallel-sided wedge. In the above formula, the constant would have to be reduced to 0·69 to meet his calculated frequency, but the edge thickening here is extreme, as the edges are as thick as the centres of sections. The torsional motion to which this formula applies is that shown by Figs. 7 and 8.

THE PORT OF RANGOON.

ALTHOUGH the last seven months of the year ended March 31, 1940, reviewed in the annual report of the Commissioners for the Port of Rangoon, were passed under war conditions, these appear to have had little adverse effect upon the year's working. Imports of coal and coke declined, but those of salt rose steeply. Exports of rice and timber rose to 2,185,450 tons and 203,397 tons, respectively. The shipments of mineral oil, amounting to 891,508 tons, presumably reflect war conditions, in that they were the largest for at least five years, but the exports of pig lead declined somewhat, to 76,836 tons. A total of 409,056 passengers used the Commissioners' wharves and jetties for landing and embarkation. Income and expenditure both exceeded the previous year's totals; the former by rather more than 3 lacs of rupees, to Rs.72,78,207, and the latter, by more than 1¼ lacs, to Rs.68,35,123. The total seaborne trade of the port, aggregating 5,431,265 net tons, represents an increase of 2 per cent. over the 1938-39 figures. Of this total, 1,877,326 tons were handled at the Commissioners' premises, a rise of about 8 per cent. over that for the previous year.

During the year, work was continued on the rebuilding of Brooking-street wharf, which was virtually completed; and the sanctioning of an estimate of Rs. 71¼ lacs enabled a start to be made with a similar reconstruction of berths 1, 2 and 3 at the Sule Pagoda wharves. Satisfactory results obtained with the first three test cylinders put down were reported on page 308 of the 149th volume of ENGINEERING. Early in the year, more test cylinders were put down, old buildings cleared from the site, and the existing wharf head dismantled, leaving a clear length of 580 ft. for new construction. The driving of 392 18-in. square concrete piles completed the first stage of the work. A staging, supported on box piles, was erected to carry the piling bridge and the screwing gantry, and the screwing of the cylinders was begun in February, 1940. The manufacture of precast A frames and walings for the first of the three berths, which was also begun in February, was 90 per cent. complete at the end of March. The policy of replacing timber jetties by reinforced-concrete structures was exemplified in April, 1939, when fire in a schooner, laden with 20,000 two-gallon tins of petrol, spread to an oil-laden lighter. Foreshore erosion, and changes in the harbour bed, continued to demand close observation. Shoaling round the wharves and jetties necessitated the removal of over 160,000 tons of spoil; and 1,140,000 tons of sand and silt were removed from Monkey Point channel and other fairways.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

The number of views given in the Specification drawings is stated in each case; where none is mentioned, the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.

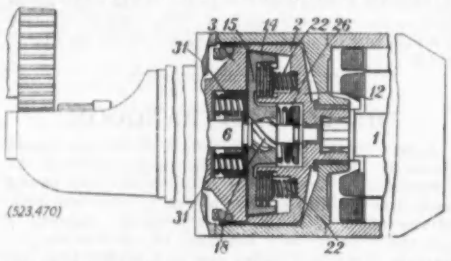
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery-lane, London, W.C.2, price 1s. each.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

INTERNAL-COMBUSTION ENGINES.

523,470. Shock-proof Self Starter. Bryce, Limited, of Hackbridge, and G. W. A. Green, of Hackbridge. (1 *Fig.*) December 31, 1938.—The invention is an arrangement of clutches which ensures a smooth take-up of the drive and protects the starter motor from shock due to the sudden application of load. The armature shaft 1 of the starter motor carries a fly-wheel assembly consisting of a cup 2 with a cover 3 through which protrudes a sliding pinion shaft 6, the protruding portion having the usual quick-pitch thread and being housed in a shroud which mounts an outer bearing for its free end. The cup has an internal wall 12 which is externally splined to drive the driving plates of a light clutch, while the inner surface 14 of the cup is tapered and constitutes the driving surface of the main clutch. The driven member of the main clutch is a disc 15 having a substantial moment of inertia, and externally tapered to fit the surface 14. At its centre it has an aperture with a quick-pitch multiple-start thread engaging a corresponding thread 18 on the pinion shaft 6. The disc has a recess housing the light clutch and splined to engage the



(523,470)

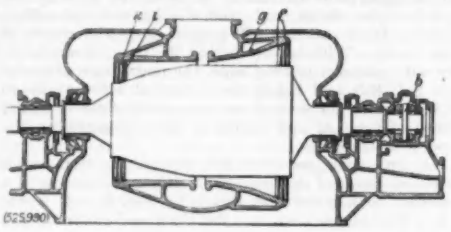
driven plates of the light clutch. A recoil spring 26 bears upon the hub of the main clutch disc 15 to assist the springs 22 in holding the clutch disengaged. At the outer end of the quick-pitch thread 18, a split ring forms an abutment for a cage housing heavy compression springs 31 within the cover 3 and bearing on a thrust washer on the cover. Between the cover and the shaft is a gland enabling the flywheel assembly 2, 3 to serve as an oil bath for the clutches. In operation, the starter motor rotates the flywheel assembly and, through the light clutch, drives the pinion shaft 6 until the pinion engages the toothed ring on the engine flywheel. During this period the main clutch is positively disengaged, so that the meshing of the pinion with the teeth on the engine flywheel is effected smoothly under light load. Since the driven plates of the light clutch are splined to the driven disc 15 of the main clutch, the latter rotates with the pinion shaft 6. Upon the engagement of the pinion with the engine flywheel, the pinion shaft is stopped and the rotating disc 15 of the main clutch runs under its own momentum along the screw-thread 18 until it comes into contact with the surface 14 of the rotating cup. The main clutch is thus smoothly engaged under light load due to the inertia of the disc 15. Thereafter, it automatically tightens itself up, since the shaft 6 is still held stationary by the engine. The torque transmitted by the main clutch being still insufficient to rotate the pinion shaft 6, the latter is unscrewed from the disc 15 and compresses the recoil spring 26 to its limit. As soon as the shaft 6 is displaced the reaction of the springs 31 is transferred to the disc 15, which is thus pressed firmly into engagement with the driving surface 14 of the cup. The main clutch is then able to transmit the full torque of the starting motor. When the engine fires, the pinion shaft is moved inwards by the springs 31 to its normal position, relieving the main clutch of load. The latter is therefore disengaged by the recoil spring 26, assisted by the springs 22 of the light clutch. (*Accepted July* 15, 1940.)

METALLURGY.

526,323. Pressure Alloying Process. Swan, Hunter and Wigham Richardson, Limited, of Walker, and W. McBain, of Newton Park. March 13, 1939. The process produces alloys, or even single-metal products, which have different physical and chemical forms from those previously obtained. To make an alloy having a 50 per cent. copper and 50 per cent. mild-steel content, equal quantities of copper and mild-steel filings are intimately mixed and placed in a solid steel container which can be simply constructed by drilling a hole of, say, $\frac{7}{8}$ in. diameter and $1\frac{1}{2}$ in. depth in a 2 in. by $1\frac{1}{2}$ in. steel bar. Sufficient mixture is used to half-fill the cavity and a plug of steel is then forced home, compacting the mixture. At about the location of the mixed filings, a heavy welding current is passed through the mould. The electrodes have an effective contact area of $\frac{3}{4}$ sq. in., and the current is maintained at from 23,500 amperes to 24,300 amperes at the secondary, for 45 seconds, until the mixture melts. As soon as the heating stage is completed, the molten copper-steel mixture is subjected to a forging pressure applied hydraulically in the absence of air. The steel plug is used for this purpose, and is a snug fit in the cavity of the mould to ensure that air is excluded. The pressure at this stage is about 15 tons per square inch. The mould is then allowed to cool, and a substantially homogeneous alloy of the copper and steel results. In an actual experiment, a specimen obtained was given a Brinell hardness test. The steel used for the mould gave Brinell hardness (Poldi) numbers of about 160 to 169, whereas the copper-steel specimen gave hardness numbers between 322 and 345. Furthermore, microscopic examination revealed that the alloy was of a remarkably homogeneous character, and also had a high degree of ductility. A wide range of single metals or mixtures can be so treated, the resulting material appearing to have changed characteristics and apparently possessing a modified structure. The apparatus used consists, most conveniently, of a spot-welding plant having hydraulically-controlled electrodes adjacent to the jaws of a hydraulic press. The jaws of the press can then hold the mould while the welding current is being passed. As soon as the current is cut off, pressure can at once be applied by the jaws. (*Accepted September* 16, 1940.)

STEAM ENGINES, BOILERS, ETC.

525,990. Double-Flow Steam Turbine. The Parsons Marine Steam Turbine Company, Limited, of Wallsend-on-Tyne, S. S. Cook, and L. M. Douglas, of Wallsend-on-Tyne. (1 *Fig.*) March 4, 1939.—The turbine is so arranged that changes of blade clearance due to different expansions of the rotor and stator during service are in the same sense for both halves of the rotor. In the central-flow turbine shown, in which the capacities of the two branches are equal, the rotor shaft has a thrust collar *b* at one end. The half of the rotor adjacent to the collar is cylindrical and the tips of the blades *f* lie on a generally conical surface, the larger diameter of which is at the end of the rotor adjacent to the collar. The associated half *g* of the stator is correspondingly coned. The other half of the rotor is generally conical in form and the tips of the blades *i* lie on a cylindrical surface concentric with the cylindrical stator, while the tips of the stator blades *k* lie closely adjacent to the external surface of the rotor. Thus, those clearances which vary with relative axial movement between rotor and stator, on the half adjacent to the collar *b*, are those between the tips of the moving blades *f* and the coned stator bore *g*, and on the other half are those between the tips of the fixed, blades *k* and the surface of the coned rotor. Therefore, relative axial movement causes all the clearances to be affected in the same way, so that, if the rotor expands

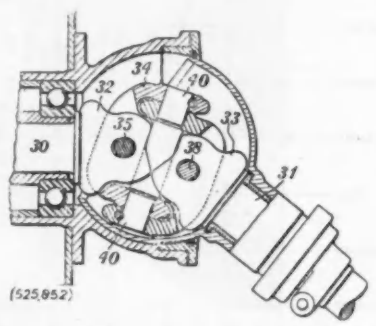


(525,990)

more than the stator, when heated up to full-power service conditions, then the thrust block faces can be so adjusted that the radial blade clearances are a minimum under those full-power service conditions. At any other conditions where the thermal expansion is less, the rotor retracts from the stator towards the collar and the blade clearances all increase. (*Accepted September* 9, 1940.)

MISCELLANEOUS.

525,852. Constant-Velocity Universal Joint. Bendix, Limited, of Birmingham, and J. S. Irving, of Birmingham. (6 *Figs.*) March 2, 1939.—In constant-velocity universal joints it is usual to locate the shafts by a ball-pin on one shaft engaging a slot on the other. When the shafts swing about the axis of the yoke trunnions, the centre of the ball-pin remains the centre of the joint so that the parts of the joint remain symmetrical. When, however, the shafts swing in the other plane, the centre of the ball-pin is displaced from the centre of the joint, causing dissymmetry of the parts and producing relative lateral movement of the shafts twice in each revolution. The invention is eliminated. The two shafts 30, 31 terminate in tongues



(525,852)

32, 33. A yoke 34 is pivoted to the tongue 32 by a swivel pin 35 of which the axis is at right angles to the axis of the shaft 30 and which is anchored in the yoke and passes through a short longitudinal slot in the tongue. A complementary yoke is similarly pivoted to the tongue 33 by a swivel pin 38, and the yokes are connected by trunnions 40. When one shaft swings in a plane at right angles to the trunnions, the slots in the tongue allow a limited movement between the yokes and the tongues parallel to the respective shafts, so that the lateral movement which occurs as the shafts rotate is confined to the yokes and there is no lateral movement of the tongues or shafts. The shafts can therefore be located by mounting them in the two halves of a spherical housing so that the joint is totally enclosed. (*Accepted September* 5, 1940.)

END OF THE ONE HUNDRED AND FIFTIETH VOLUME.

ENGINEERING

Offices for Publication and Advertisements, 35 & 36, Bedford Street, Strand, London, W.C.2.

We desire to call the attention of our readers to the fact that the above is our REGISTERED ADDRESS and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," LESQUARE, LONDON.

TELEPHONE NUMBER—TEMPLE BAR 3663 (2 lines)

EMERGENCY ADDRESS DURING HOSTILITIES

18-20, Compton Road, Hayes, Middlesex.

Telephone :

Advertising Dept., HAYES 1723.

Editorial Dept., HAYES 1730.

For particulars of Subscription Rates see Leader Page, centre of paper.

"ENGINEERING" INDEX

The Editorial Index to Vol. 149 (January-June, 1940) is now ready and will be sent to any reader, without charge and postage paid, on application being made to the Publisher. In order to reduce the consumption of paper, no copies of the Index are being distributed, except in response to such applications.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, etc., is 4/- for the first four lines or under and 1/- per line up to one inch. The line averages six words. When an advertisement measures an inch or more the charge is 12/- per inch. Payment must accompany all orders for single advertisements (which should be delivered not later than first post on Wednesday, otherwise their insertion cannot be guaranteed). 5% allowed on 6, 12½% on 13, 25% on 26, and 33⅓% on 52 weekly insertions.

Unless the classification is clearly stated on the copy, advertisements appearing in these columns will be classified at the discretion of the Publisher.

The proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

EDUCATIONAL.

AUTHORITATIVE CORRESPONDENCE TRAINING

25 FIRST PLACES

and HUNDREDS OF PASSES in the A.M.Inst.C.E., A.M.I.Mech.E., A.M.I.E.E., A.F.R.Ae.S., A.M.I.Chem.E., C. & G., etc., Examinations have been gained by T.I.G.B. Students.

Especially in view of Air Raid and Working Conditions, study at home with the T.I.G.B. in order to achieve the best progress and results. Write to-day for "The Engineer's Guide to Success"—FREE—containing the world's choice of Engineering Courses—over 200—covering all branches and recognised qualifications. Mention branch, post or qualifications that interests you. The T.I.G.B. guarantees training until successful.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN,
78, Temple Bar House, London, E.C.4.

PUBLIC APPOINTMENTS.

CROWN AGENTS FOR THE COLONIES.

COLONIAL GOVERNMENT APPOINTMENTS.

Applications from qualified candidates are invited for the following POSTS :—

M/9316. ASSISTANT ENGINEER required for the Drainage and Irrigation Department, Malaya, for three years, with possible permanency. Salary, $400 a month, rising by annual increments of $25 a month to $800 a month. (The Government rate of exchange is now 2s. 4d. to the dollar.) A children's allowance is payable to married officers with children. Free passages and, if married, for wife and family not exceeding four persons. Liberal leave on full salary. Candidates, age 23-26, must be Corporate Members of the Institution of Civil Engineers or hold an engineering degree recognised as granting exemption from Sections A and B of the A.M.I.C.E. examination, and have had at least two years' experience on engineering works after taking degrees or completing articles, at least one year of which should have been spent in a drawing office.

M/9393. MAINTENANCE ENGINEER required by the Government of British Guiana for the Transport and Harbours Department for one tour of three years. Salary, £500-£25-£600 a year. Free passages and, if married, for wife and children not exceeding four persons. Leave on full salary. Candidates must be fully qualified Civil Engineers and have had good training in Track Maintenance, embracing yards layout and the laying down of points and crossings.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience and mentioning this paper, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting the reference number against the appointment for which application is made. L 28

THE NORTH METROPOLITAN POWER STATION COMPANY, LIMITED.

WILLESDEN POWER STATION.

CLERK OF WORKS (PLANT).

Applications are invited for the POST of CLERK OF THE WORKS (PLANT) at the Company's Willesden Power Station, where plant to operate at 1,400 lb. per sq. in., 960 deg. F., is being installed comprising five 150,000 lb. per hour boilers and two 32,000 kW. turbo alternators and auxiliaries.

Apply, stating experience, age and salary required to the CHIEF ENGINEER, THE NORTH METROPOLITAN POWER STATION COMPANY, LIMITED, Northmet House, Cannon Hill, London, N.14. K 986

AUCTION SALES.

EDWARD RUSHTON, SON AND KENYON (Est. 1855)

AUCTIONEERS, VALUERS, AND FIRE LOSS ASSESSORS OF ENGINEERING WORKS PLANT AND MACHINERY

YORK HOUSE, 12, YORK STREET, MANCHESTER.
Telephone : 1937 Central (2 lines).
Telegrams : "Russonken, Manchester."
874

APPOINTMENTS OPEN.

It is advisable when sending testimonials to forward copies and NOT originals.

If you are unable to obtain the POST you REQUIRE, why not insert an advertisement in our "Situations Wanted" Columns ?

These are seen by the Heads of all the leading concerns.

The cost is small, being 4/- for the first four lines or under, and 1/- per line after. Advertisements are accepted up to First Post on Wednesdays.

Superintendent of Employment for large Engineering Works in Hertfordshire. Duties would include supervision of labour engagement; Also training schemes for apprentices and trainees.—State age, experience and salary required, to L. 13, Offices of ENGINEERING.

Required, Production Manager for large Aero Works—previous experience in large Machine Shop and control of Labour essential. —Write, stating previous experience, to L 27, Offices of ENGINEERING.

Buying Office, Senior Male ASSISTANTS REQUIRED with experience in Engineering Buying Office.—Full details of experience, also age and salary required, to L 31, Offices of ENGINEERING.

Assistant Buyer (Male) REQUIRED with Engineering Buying Office experience. Full details of experience, also age and salary required, to L 30, Offices of ENGINEERING.

TO ADVERTISERS UNDER BOX NUMBERS

The Proprietors are prepared, for the benefit of applicants to INSERT, FREE OF CHARGE, Notices (limited to two lines) that vacancies are filled.

See also Page 52

SITUATIONS WANTED.

If you are unable to obtain the MAN you REQUIRE, why not insert an Advertisement in our "Appointments Open" Column ?

This is the quickest way of securing a man possessing the qualifications you require.

The cost is 4/- for the first four lines or under, and 1/- per line after. Advertisements are accepted up to First Post on Wednesday.

Engineer, 39, A.M.I. Loco.E., experience, standard gauge and light railway locomotives, Diesel engines, steam plant operation, mining machinery, cranes, welding, D.O. Present employed as locomotive erector. Seeks better position at home or abroad.—L 25, Offices of ENGINEERING.

See also Page 52

WANTED.

Please offer us your Surplus MACHINES. As Licensed Dealers in Machine Tools, we have numerous enquiries on our books for all types of Machines for work of vital National importance. Our representatives will inspect and make spot cash offers for Machine Tools and Sheet Metal Working Machinery of every description.—F. J. EDWARDS, LTD., 359, Euston Road, London, N.W.1. Telephone No., EUSTON 4681 ; Telegrams: Bescotools, Norwest, London. K 940

See also Page 52.

WORK WANTED

Work Wanted.

STEEL PRESSINGS, or FLANGING, suitable for Hydraulic Presses :—

(1) 1,500-ton 14 ft. by 5 ft. 3 in. between columns, daylight 12 ft.
(2) 500-ton 12 ft. by 6 ft. 9 in. between columns, daylight 11 ft. 6 in.
(3) 100-ton 7 ft. by 3 ft. between columns, daylight 4 ft. 6 in.

Heating and annealing furnaces to match.

ALSO WORK FOR HEAVY LATHE, 74 in. face plate : 13 ft. 6 in. length.

COCHRAN & CO., ANNAN, LTD., ANNAN, SCOTLAND. K 879

See also Page 52.

PATENTS.

It is desired to secure the full commercial development in the United Kingdom of BRITISH PATENTS NOS. 415415 and 450380, which relate to "APPARATUS FOR CONSTRUCTING LEVEES, EMBANKMENTS AND THE LIKE," either by way of the grant of Licences or otherwise on terms acceptable to the Patentee. Interested parties desiring copies of the patent specifications and further particulars, should apply to STEVENS, LANGNER, PARRY & ROLLINSON, 5 to 9, Quality Court, Chancery Lane, London, W.C.2. L 29

The proprietor of Letters Patent No. 416182 and No. 428206, relating to "Gauging and Controlling Thickness of Non-Magnetic Material in Sheet Form," desires to grant Licences or enter into other arrangements to exploit the Patented Inventions and insure its full commercial development in this country.—Inquire, L 26, Offices of ENGINEERING.

FOR SALE.

SERVICE EDWARDS VALUE

Double-Sided Fly Press, 10 in. between uprights, 11 in. bed to guides, 2¼ in. square ram with brass slides, 2¼ in. diameter screw, fly-arm with two ball weights.

New Pexto Hand Lever Double-Ended Punching and Shearing Machine with cast-steel frame. Length of blades 7 in. ; capacity, any length or width of sheet up to 8 gauge thick, flats 1½ in. by ½ in., punch gap 5½ in., will punch ¾ in. holes through ¾ in. thick. Weight about 4 cwt.

Power Geared Bending Rollers, 49½ in. long by 4¾ in. diameter, takes sheets up to ½ in. thick, adjustable back roller. Driving pulleys 18 in. by 3½ in.

Set of Geared Power-Driven Bending Rollers. Length of rolls 49 in. Capacity ⅜ in. plate. Diameter of back roller 7½ in. Two front rollers 6 in. diameter. Driving pulleys 18 in. by 3½ in. Weight 35 cwt.

Power Geared Bending Rollers. Capacity 4 ft. 3 in. by ⅜ in. Diameter of rolls 8½ in. Weight 2 tons.

SIEMENS SCHUKERTS Spot Welding Machine. Depth of gap 24 in. Suitable for 210 volts single phase, 50 cycles. 12 kVA. Capacity up to ⅛ in. added thickness. Water-cooled electrodes. Single heating speed. Adjustable top and bottom heads. Automatic cut out. Could be converted into a seam welder.

MACHINE TOOLS, NEW AND USED. Large Stocks of every Description. Attractive Prices.

F. J. EDWARDS, LTD.,
359-361, EUSTON ROAD,
LONDON, N.W.1.
Telephone : EUSTON 4681 (6 lines).

HERBERT

GRINDERS IN STOCK

NORTON 14 in. and 22 in. by 50 in. PLAIN CYLINDRICAL, overhead belt drive, gap bed, countershaft pump, tank and fittings.

NORTON 24 in. by 240 in. PLAIN CYLINDRICAL self-contained motor drive, separate headstock motor, six steadies, pump, tank and fittings.

HEALD NO. 60 CYLINDER, belt drive, with countershaft, grinding spindle.

LUMSDEN NO. 92-LES SURFACE, motor drive.

CHURCHILL 30 in. DOUBLE-ENDED DISC, belt drive, countershaft, work rests.

ARCHDALE SINGLE-SPINDLE HONING MACHINE, fast and loose pulley drive, pump, tank and fittings.

NOLL MONNARD CENTRELESS POLISHING MACHINE, fast and loose pulley drive. Size of grinding wheel 16 in. by 4 in. (NEW.)

All the above are AS PURCHASED unless otherwise stated.

Offered subject to prior sale.

WIDE RANGE OF MACHINE TOOLS IN STOCK AT COVENTRY. FULL PARTICULARS SENT ON REQUEST.

We are Authorised Dealers under licence from the Minister of Supply.

ALFRED HERBERT LTD., COVENTRY.

Telephone : Coventry 88781 (12 lines). Telegrams : "Lathe, Coventry."

FROM STOCK. HEAVY DUTY MACHINE TOOLS.

HORIZONTAL BORERS.

4½ in. dia. spindle floor type BORING, MILLING AND DRILLING MACHINE. (SPENCER.) T-slotted base, 9 ft. 3 in. by 5 ft. 0 in. 2¼ in. dia. drilling spindle. Arranged for motor drive. A.C. equipment.

3½ in. dia. spindle HORIZONTAL BORING MACHINE. (G. A. HARVEY.) 15 ft. 0 in. travel of column on base. Approx. 11 ft. 0 in. vert., travel of saddle on col. Approx. weight, 26 tons.

No. 2 DETRICK & HARVEY HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

S.S. & S.C. LATHES.

28 in. cens. S.S. & S.C. LATHE (HARVEY), on 60 ft. bed.

20 in. cens. S.S. & S.C. LATHE (JOHN STIRK), on 18 ft. 6 in. flat gap bed. 5-step cone drive, back geared.

15½ in. cens. S.S. & S.C. LATHE (MILEYS), on 15 ft. 6 in. flat gap bed. 48 in. dia., 26 in. dia., and 24 in. dia. faceplates. 4-step cone drive, back geared.

PLANING MACHINES.

29 ft. by 3 ft. 6 in. by 3 ft. 6 in. capacity GEO. SWIFT PLANER. Bed in 3 pieces. RACK DRIVEN, V SLIDES. Electrical equipment with the machine.

12 ft. 0 in. by 3 ft. 6 in. by 3 ft. 6 in. ASQUITH PLANER. VULCAN CLUTCH DRIVE.

10 ft. by 3 ft. by 2 ft. 6 in. capacity DETRICK & HARVEY OPENSIDE PLANER. Belt driven.

RADIAL DRILLING MACHINES.

8 ft. 0 in. swing CAMPBELL & HUNTER RADIAL DRILL. 3½ in. dia. spindle, No. 6 M.T. Arranged for Tapping. Fast and loose pulleys through gearbox drive.

4 ft. 6 in. swing MARSHALL RADIAL DRILL. Gearbox drive. Arranged for Tapping.

MULTI-SPINDLE DRILLS.

SEVERAL No. 12 Type C NATCO MULTI-SPINDLE DRILLING MACHINES. 12 spindles. Excellent condition.

BAUSH 12-spindle (10 fitted) MULTI-SPINDLE DRILL. Direct motor driven type. Push button control.

PILLAR DRILLS.

TWO 28 in. swing JONES & SHIPMAN PILLAR DRILLING AND TAPPING MACHINES. 8 spindle speeds.

LARGE STOCKS OF SMALLER PILLAR DRILLING MACHINES.—NEW AND SECOND-HAND.

SLOTTING MACHINES.

15 in. stroke CRAVEN SLOTTER. 3 ft. 0 in. dia. table.

12 in. stroke NOBLE & LUND SLOTTER. 24 in. dia. table.

SHAPING MACHINES.

16 in. stroke cone-driven SHAPER. 14 in. by 10 in. table.

16 in. stroke BUTLER ALL GEARED HEAD SHAPER.

INSPECTION INVITED.

THOS. W. WARD, LIMITED
ALBION WORKS, SHEFFIELD.
Phone 26311 (15 lines). 'Grams Forward, Sheffield.
L 24

Public Appointments and other Classified Advertisements continued on last White Pages.

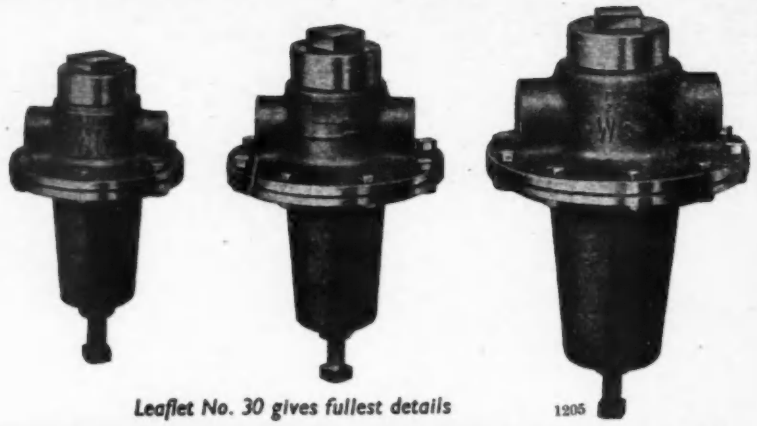
Too late for Classification see page 52.

W.& J. Valves for efficiency

REDUCING VALVES FOR AIR GAS, WATER OR STEAM ETC . . . .

Designed by experts to give a minimum sympathetic pressure drop with variations of upstream pressure and a maximum flow with minimum working drop and absence of pressure creep with no flow. Well balanced. Adjustable. No Glands. No sticking or chattering under any conditions. All parts in contact with pressure stream are of best quality gun metal.

Every valve tested before dispatch and guaranteed for 12 months. Please state purpose of valve and pressure range when ordering.



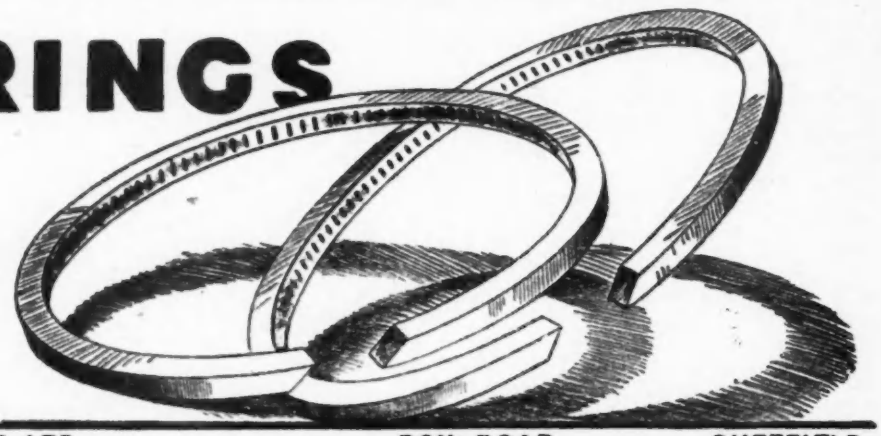
Leaflet No. 30 gives fullest details 1205

W AND J

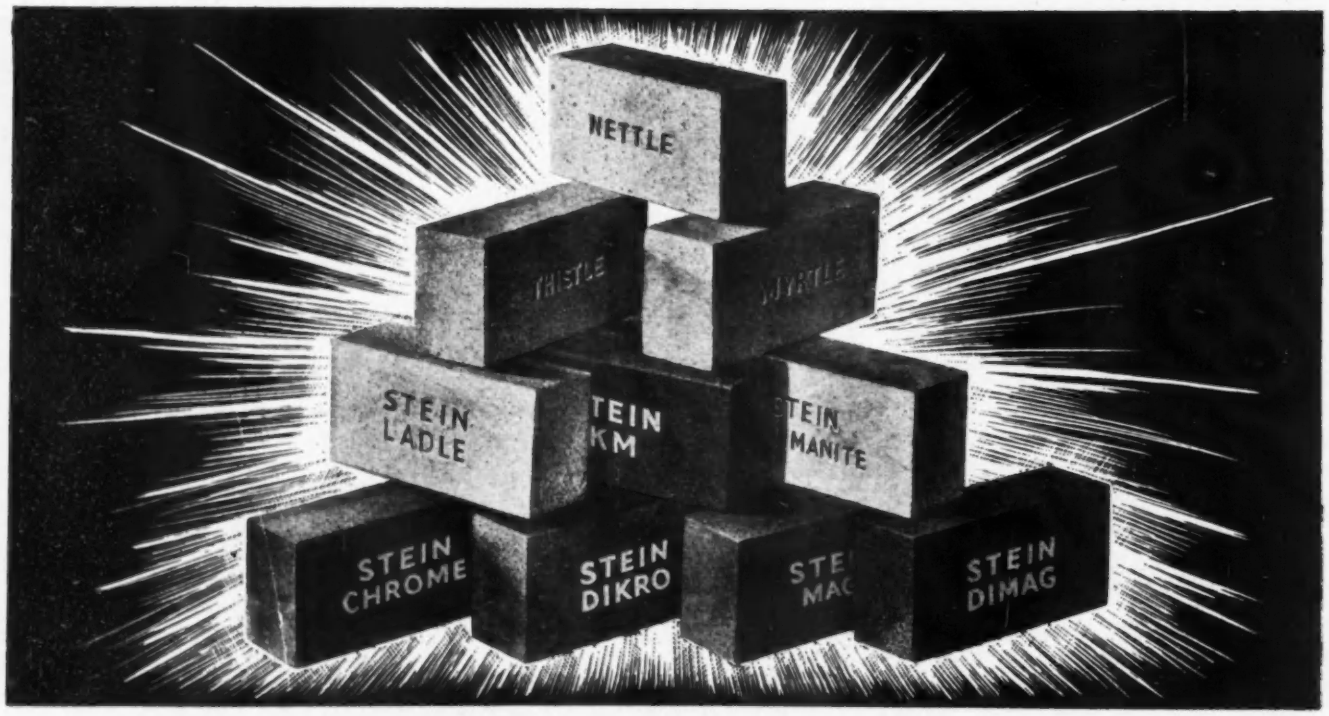
WILLIAMS & JAMES ENGINEERS GLOUCESTER ENGLAND

STANDARD'S
PISTON RINGS

IN HIGH TENSILE CAST IRON
ADMIRALTY BRONZE & GUNMETAL
AMMONIA RESISTING IRON
AND STEEL



THE STANDARD PISTON RING & ENGINEERING CO LTD DON ROAD SHEFFIELD



STEIN REFRACTORIES

INCREASED output under war conditions places an additional stress on high temperature furnaces and now, more than ever before, the truest economy is to employ refractory linings of the best quality obtainable. We are always glad to co-operate with users in overcoming their refractories problems. 870

JOHN G. STEIN & CO. LTD., BONNYBRIDGE, SCOTLAND.

INDEX TO ADVERTISEMENTS

	PAGE
Abbott & Co. (Newark), Ltd.	39
Aerograph Co., Ltd.	11
Ailsa Craig, Ltd.	1
Alexander Herbert & Co., Ltd.	47
Alldays & Onions, Ltd.	1
Andamite, Ltd.	11
Armstrong-Whitworth & Co. (Pneumatic Tools), Ltd.	2
Arrol, Sir Wm., & Co., Ltd.	37
Ash, Joseph, & Son, Ltd.	47
Asquith, Wm., & Co., Ltd.	55
Automotive Eng'g. Co., Ltd.	12
Babcock & Wilcox, Ltd.	1 & 21
Barber & Colman, Ltd.	15
Barry, Henry, & Cook, Ltd.	1
Beebee, Alfred, Ltd.	9
Bellamy, John, Ltd.	1
Birmingham Battery & Metal Co., Ltd.	41
Bolton, C. V.	8
Bolton's Superheater & Pipe Works, Ltd.	40
Booth, James, & Co. (1915), Ltd.	26
Brammer, H., & Co., Ltd.	45
British Ropeway Eng'g. Co., Ltd.	40
British Steam Specialties, Ltd.	30
British Thomson-Houston Co., Ltd.	19
British Timken, Ltd.	35
British Twin Disc & Clarifiers, Ltd.	1
Broady, Wm., & Sons	42
Brookes & Adams, Ltd.	40
Broom & Wade, Ltd.	51
Brotherhood, Peter, Ltd.	1
Brown, Lenox & Co. (London), Ltd.	1
Brush Electrical Eng'g. Co., Ltd.	8
Cambridge Instrument Co., Ltd.	28
Clarke, Chapman & Co., Ltd.	20
Clayton, Son & Co., Ltd.	44
Cleveland Bridge & Eng'g. Co., Ltd.	43
Climax Rock Drill & Eng'g. Works, Ltd.	7
Clyde Structural Iron Co., Ltd.	42
Coltman, W. W., & Co., Ltd.	51
Conveyor & Elevator Co., Ltd.	6
Cooper Roller Bearings Co., Ltd.	1
Coventry Climax Engines, Ltd.	24
Cradley Boiler Co., Ltd.	1
Craven Bros. Crane Division, Ltd.	41
Crofts (Engineers), Ltd.	44
Crosby Valve & Eng'g. Co., Ltd.	15
Crosthwaite Furnaces & Scriven Machine Tools, Ltd.	31
Dawson Bros., Ltd.	11
Dawson & Downie, Ltd.	51
Delta Metal Co., Ltd.	52
Donkin, The Bryan, Co., Ltd.	10
Douglas Lawson & Co., Ltd.	8
Drum Eng'g. Co., Ltd.	8
Drysdale & Co., Ltd.	41
Edwards, F. J., Ltd.	3 & 5
Electromagnets, Ltd.	31
Elliston, Evans & Jackson, Ltd.	46
Expanded Metal Co., Ltd.	44
Fenner, J. H., & Co., Ltd.	6
Ferguson Bros. (P. G.), Ltd.	1
Ferodo, Ltd.	56
Firth-Derihon Stampings, Ltd.	34
Firth - Vickers Stainless Steels, Ltd.	28
Flather & Co., Ltd.	8
Fluxite, Ltd.	31
Fowler, John, & Co. (Leeds), Ltd.	16
General Electric Co., Ltd.	39 & 46
Godins, "The Rollers of Steel Sections," Ltd.	10
Goodall, Clayton & Co., Ltd.	29
Grafton Cranes, Ltd.	47
Greenwood & Batley, Ltd.	38
Gresham & Craven, Ltd.	14
Gwynnes Pumps, Ltd.	9
Hadfields, Ltd.	28
Hull, J. & E., Ltd.	1
Hamworthy Eng'g. Co., Ltd.	32
Harcourt, David, Ltd.	9
Heap, Joshua, & Co., Ltd.	54
Heenan & Froude, Ltd.	29
Herbert, Alfred, Ltd.	3, 26 & 52
Hick, Hargreaves & Co., Ltd.	5
Hingley, N., & Sons, Ltd.	11
Hoffmann Mfg. Co., Ltd.	22
Hopkinsons, Ltd.	23
Hudswell, Clarke & Co., Ltd.	1
Hunt, Thos., & Sons	1
Hurst, Nelson & Co., Ltd.	1
International Furnace Equipment Co., Ltd.	54
Jenkins, Robert, & Co., Ltd.	15
Johnson, W. F., & Co. (London), Ltd.	8
Keith, Blackman, Ltd.	17
Kenyon, A., & Co., Ltd.	41
Kitchen & Wade, Ltd.	13
Lafarge Aluminous Cement Co., Ltd.	9
Lancaster & Tonge, Ltd.	50
Levy, B., & Co.	1
Lightalloys, Ltd.	1
Lindsay, Henry, Ltd.	31
Londex, Ltd.	52
Luke, H., Ltd.	30
McLaren, J. & H., Ltd.	46
MacPhail & Kay, Ltd.	1
Macrome, Ltd.	1
Marbaix, Gaston E., Ltd.	41
Mavitta Drafting Machines, Ltd.	1
Mechans, Ltd.	8
Mek-Elek Eng'g. Ltd.	8
Mercer, Edw., Ltd.	28
Metallic Valve Co., Ltd.	51
Metropolitan - Vickers Electrical Co., Ltd.	49
Micanite & Insulators, Ltd.	52
Mills, Wm., Ltd.	17
Modern Machine Tools, Ltd.	30
Monarch Tool Co., Ltd.	10
Morris, Herbert, Ltd.	9 & 47
Moss Gear Co., Ltd.	22
Motherwell Bridge & Engineering Co., Ltd.	47
Murex Welding Processes, Ltd.	1
Newbury Diesel Co., Ltd.	31
Northey-Boyce Rotary Eng'g. Co., Ltd.	52
Oakey, John, & Sons, Ltd.	13
Parsons, C. A., & Co., Ltd.	36
Parsons Eng'g. Co., Ltd.	46
Patent Retorts, Ltd.	41
Paterson Eng'g. Co., Ltd.	1
Pearn, Frank, & Co., Ltd.	44
Petters, Ltd.	47
Platt, Sam, Ltd.	1
Pratchitt Bros., Ltd.	9
P.T.P. & W.N.P.A., Ltd.	48
Ransome & Maries Bearing Co., Ltd.	56
Ransomes & Rapier, Ltd.	1
Ransomes, Sims & Jefferies, Ltd.	51
Reavell & Co., Ltd.	53
Reid Gear Co., Ltd.	9
Renold & Coventry Chain Co., Ltd.	43
Research Engineers, Ltd.	1
Rhodes, Brydon & Youatt, Ltd.	46
Rice & Co. (Leeds), Ltd.	53
Robey & Co., Ltd.	9
Rodgers Bros., Ltd.	41
Royce, Ltd.	6
Royles, Ltd.	45
Rushton, Edward, Son & Kenyon	3
Russell, G., & Co., Ltd.	1
Sciaky Electric Welding Machines, Ltd.	1
Scott, Hugh J., & Co. (Belfast), Ltd.	15
Serck, H. O., Ltd.	46
Shaw, Francis, & Co., Ltd.	41
Shaw, W., & Co., Ltd.	38
Simmonds Aerocessories, Ltd.	27
Simons, Wm., & Co., Ltd.	7
Smedley Bros., Ltd.	52
Smooth-On Mfg. Co.	43
Somers, Walter, Ltd.	1
Spencer-Bonecourt, Ltd.	1
Spiral Tube & Components Co., Ltd.	45
Stalker Drill Works, Ltd.	53
Standard Piston Ring & Eng'g. Co., Ltd.	4
Steele & Cowlishaw	14
Stein, J., & Co., Ltd.	4
Stewarts & Lloyds, Ltd.	33
Stone, J., & Co., Ltd.	32
Strachan & Henshaw, Ltd.	29
Sugden, T., Ltd.	10
Taylor, Chas. (B'ham), Ltd.	14
Taylor & Challen, Ltd.	1
Taylor, Taylor & Hobson, Ltd.	50
Technological Institute of Great Britain	3
Terry, H., & Sons, Ltd.	39
Thomas & Bishop, Ltd.	9
Thompson, John (Kennicott Water Softeners), Ltd.	1
Thornton, A. G., Ltd.	14
Tonks, John, & Co.	41
Town, Fred, & Sons	31
Turbine Furnace, Ltd.	16
Turbine Gears, Ltd.	42
United Steel Cos., Ltd.	25
United Strip & Bar Mills	25
Universal Asbestos Mfg. Co., Ltd.	16
Vaughan Crane Co., Ltd.	51
Victaulic Co., Ltd.	6
Visco Eng'g. Co., Ltd.	1
Wailes, George, & Co., Ltd.	1
Wakelin, F. H., Ltd.	51
Wallwork Gears, Ltd.	47
Ward, Thos. W., Ltd.	3, 52 & 55
Ward, Wm., & Son (Sheffield), Ltd.	1
Wellman Smith Owen Eng'g. Corp., Ltd.	45
Wells, A. C., & Co., Ltd.	45
Williford & Co., Ltd.	1
Williams & James	4
Winn, W. Martin, Ltd.	13
Wiseman, Alfred, & Co., Ltd.	43
Worthington - Simpson, Ltd.	18
Yarrow & Co., Ltd.	1

"ENGINEERING" CLASSIFIED DIRECTORY OF CURRENT ADVERTISEMENTS

Contains the Telegraphic Addresses, Codes and Telephone Numbers of our Advertisers, also Trade Names of Articles Advertised, and Glossaries for the use of Foreign Buyers, in German, French, Italian and Spanish.

A copy of the current edition will be sent gratis on application to the publisher.

☞ **THE NEXT REGULAR COLOURED ADVERTISEMENTS WILL APPEAR IN OUR ISSUE OF JAN. 24, 1941.**

MODERN 'BESCO' SHEET METAL WORKING MACHINERY

SIMPLIFIES INTRICATE WORK

SEND FOR STOCK LIST

F. J. EDWARDS LTD.

PROMPT DELIVERIES

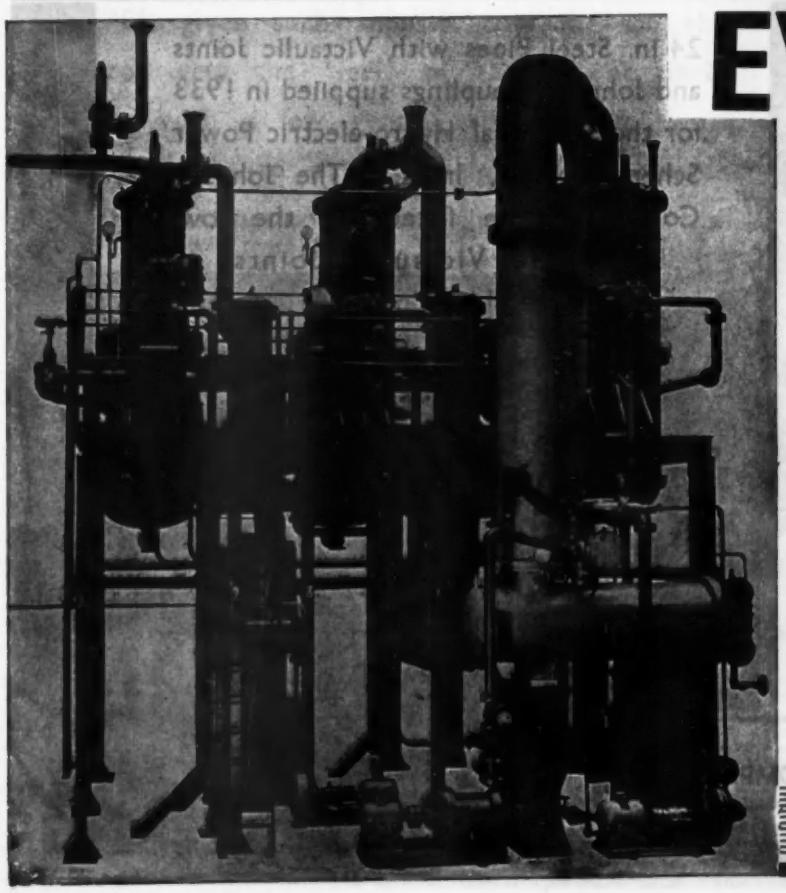
Phone EUSton 4681

359-361, EUSTON RD., LONDON, N.W.1.

NEW & USED MACHINE TOOLS & RECONDITIONED MACHINERY OF ALL TYPES

HICK HARGREAVES

EVAPORATING PLANT



Triple effect central evaporating plant, producing 20,000 lbs. of distillate per hour when supplied with live steam at 250 lbs. per square inch gauge and raw water at 60° F.

HICK, HARGREAVES & CO. LTD. AD 58A

Telephone: 1373 (3 lines) BOLTON Telegrams: "HICK, BOLTON"

CONVEYOR AND ELEVATOR Co (1938) LTD.

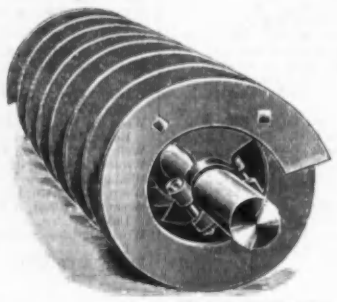
BULL BRIDGE WORKS,

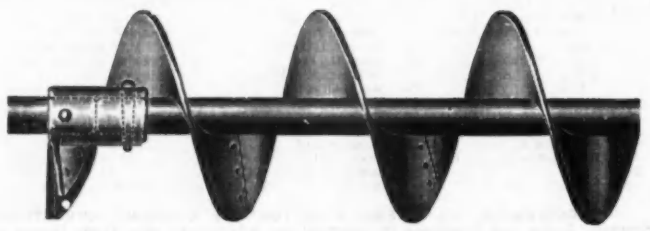
Telegrams: "Conveyor, Accrington."

Accrington, Lancashire.

Telephone: No. 2779.

SPIRAL CONVEYORS, BUCKET ELEVATORS, Etc.





It's a long story but

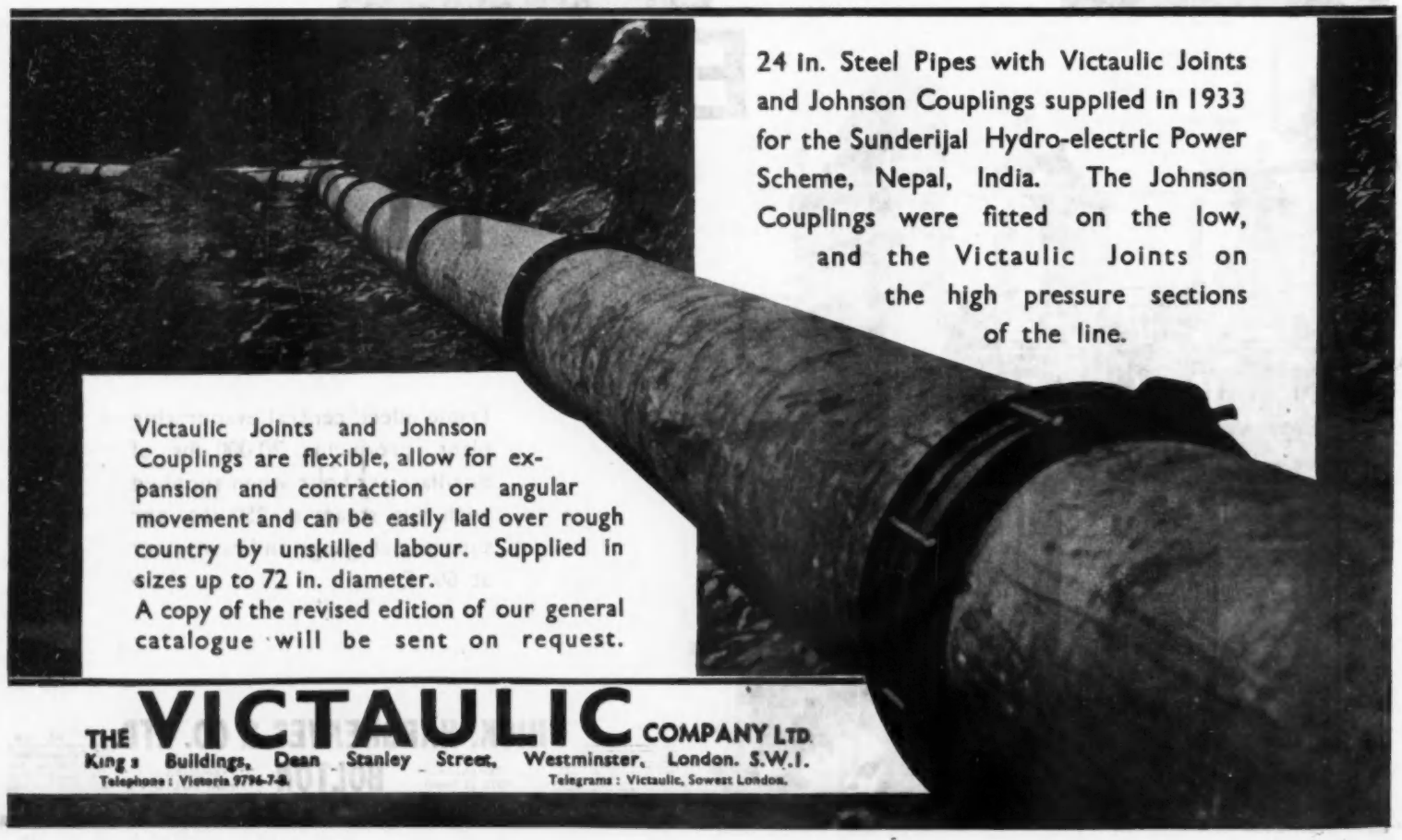
there are five good reasons why "FENNER" V-ROPES stick to their grooves, resist slipping, flex easily and last longer.

1. Top tension rubber — resilient.
2. Load carrying cords — at pitchline in parallel layers — concentrate strength.
3. Bottom rubber — tough, heat resisting — runs cool at high speeds.
4. Inner cover—reinforcement—increases rope life
5. Outer cover—bias cut—resists ageing and wear

All "V" Rope Orders and correspondence now to be addressed to Beck Lane, Mills, Heckmondwike, Yorks.

J. H. FENNER & Co. LTD. HULL England AND AT LONDON · MANCHESTER BIRMINGHAM · BELFAST & CALCUTTA

VICTAULIC JOINTS & JOHNSON COUPLINGS



24 in. Steel Pipes with Victaulic Joints and Johnson Couplings supplied in 1933 for the Sunderijal Hydro-electric Power Scheme, Nepal, India. The Johnson Couplings were fitted on the low, and the Victaulic Joints on the high pressure sections of the line.

Victaulic Joints and Johnson Couplings are flexible, allow for expansion and contraction or angular movement and can be easily laid over rough country by unskilled labour. Supplied in sizes up to 72 in. diameter.
A copy of the revised edition of our general catalogue will be sent on request.

THE VICTAULIC COMPANY LTD.
King's Buildings, Dean Stanley Street, Westminster, London. S.W.1.
Telephone: Victoria 9796-7-8. Telegrams: Victaulic, Sowest London.

Telegraphic Address:—
"SIMONS RENFREW."
"SIMONISM, LONDON."

Marine Dredge Plant
OF ALL DESCRIPTIONS AND UP TO THE HIGHEST CAPACITY.

Constructors of
HOPPER AND BARGE-LOADING BUCKET DREDGERS.
BARGE-LOADING RECLAMATION & "SIMONS" CUTTER SUCTION DREDGERS.

Proprietors of
ALFRED WATKINS' BRITISH PATENT for ROTARY SPUDS

WM. SIMONS and CO., LTD.

"SIMONS"

PATENT
CUTTER
HOPPER

DREDGERS

Codes:—
A B C (5th Edition).
SCOTT'S (10th Edition).
BENTLEY'S

TRAILING SUCTION HOPPER DREDGERS.
GOLD AND TIN RECOVERY DREDGERS.
HOPPER BARGES.
FERRY STEAMERS.
REPLACE PARTS for EXISTING DREDGERS.
INVENTORS AND FIRST CONSTRUCTORS OF "HOPPER" DREDGERS AND ELEVATING DECK FERRY STEAMERS.

-RENFREW-
near GLASGOW.

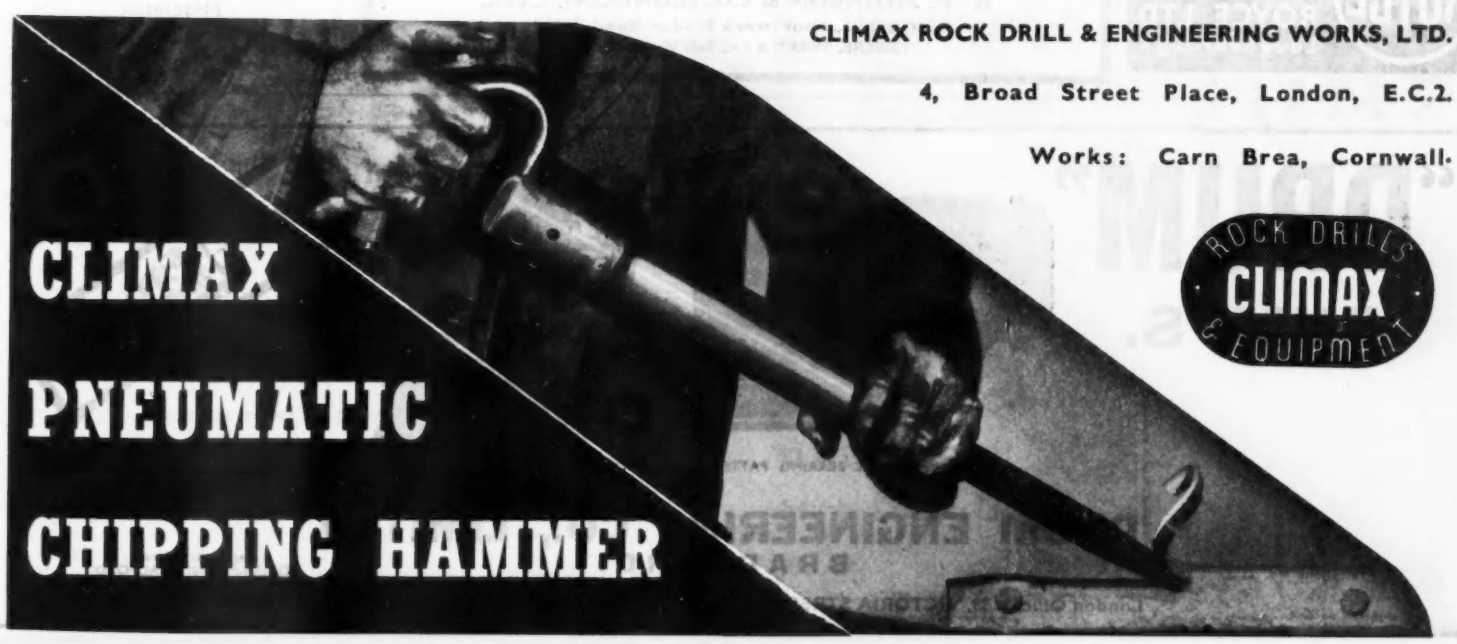
LONDON OFFICE: 83, VICTORIA ST., S.W.

3138

The way to turn out clean work—quickly!

● The special spool-valve gear in this CLIMAX CHIPPER gives such smooth control that the operator gets the 'feel' of the job at once. Starting with a few gentle taps he can work up confidently to a very high chipping speed. The air consumption is low—and, owing to the fine precision limits to which the specially hardened moving parts are ground, the consumption *remains* low even after continuous hard use. This is a light, handy tool that will speed-up production wherever there is chipping to be done. May we send you full details?

CLIMAX ROCK DRILL & ENGINEERING WORKS, LTD.
4, Broad Street Place, London, E.C.2.
Works: Carn Brea, Cornwall.



9918 TAS/C2

BRUSH for motors
LOUGHBOROUGH
4-50-6

DOUGLAS LAWSON PULLEYS *facilitate production.* Combining lightness and strength, they offer far-seeing economy and 100% efficiency.
DOUGLAS, LAWSON AND CO. LTD.
BIRSTALL, LEEDS

TELESCOPES, MICROSCOPES, GOGGLES, ETC.
C. V. BOLTON, F.S.M.C.
49a½, Leigh Road, Leigh, Lancs.
Telephone 527
SEND FOR LISTS OF SAFETY AND OPTICAL GOODS 715

MECHANS LIMITED,
Engineers & Contractors
SCOTSTOUN IRONWORKS, GLASGOW
LONDON OFFICE:
10, Princes Street, Westminster, S.W.1
See Illustrated Advertisement appearing Dec. 13, page 88. 6418

ROYCE
Electric Cranes of every type
ROYCE LTD
Loughborough

A MODERN PACKING FOR PRESENT-DAY CONDITIONS

"PALMETTO"
REG. TRADE MARK
PACKING

Has no equal for Long, Economical Service under STEAM (HIGH-PRESSURE AND SUPERHEATED) and COMPRESSED AIR

Made from the highest-grade, longest-fibre Asbestos obtainable.

Built up with a layer-upon-layer construction, giving greater strength than when made of rolled-up asbestos sheet.

Each single strand is thoroughly lubricated with a specially compounded lubricant *before* braiding.

The result is a packing that lasts longer; therefore, worth more, as it costs less in the long run.

Send for ABC Chart of Services. Also Free working sample. State size of packing used and conditions of service.

W. F. JOHNSON & CO. (LONDON), LTD.,
229 & 231, Southwark Bridge Road, S.E.1.
GREENE, TWEED & Co., Sole Manufacturers.

Reprinted from "ENGINEERING."

Third Edition.

"THE LAWS OF HEAT TRANSFER"

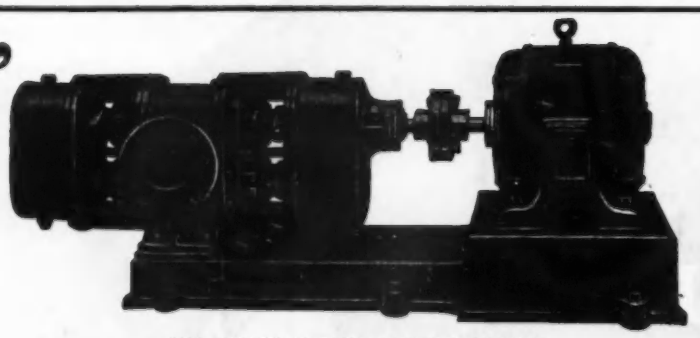
By

H. MEDWAY MARTIN, Wh.Sc., F.C.G.I.

Crown 4to, 20 pp. Paper Cover.
Price 2s. net.

Offices of "ENGINEERING," 18-20, Compton Road, Hayes Middlesex.

"DRUM" PUMPS.



BALL BEARING PATTERN MOTOR-DRIVEN PUMP

Drum Pumps

DRUM ENGINEERING CO., LIMITED,
BRADFORD.

Telephone No. 2358.
Telegraphic Address: "DRUM-PHONE-BRADFORD."
London Office: 38, VICTORIA STREET.
Telephone No.: ABBEY 3961.

FULLY MOBILISED

Night and day we are producing Ciment Fondu Aluminous Cement as fast as we can ; and, as fast as we make it, it goes to fill urgent orders for National work of paramount importance. It is a matter of deep regret that many of our good friends have been unable to obtain supplies and we ask them to extend their forbearance. We are certain it will be understood that any inconvenience caused is due solely to the fact that National needs must come first.

CIMENT FONDU
BRITISH MADE

LAFARGE ALUMINOUS CEMENT COMPANY LTD., THE KILNS, RIPLEY, SURREY. Telephone : Ripley 318 & 319

3.784D

ALFRED BEEBEE
LIMITED
WEDNESBURY
Bolts, Nuts, Studs, and Repetition Work.

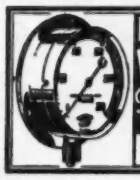
DRYING MACHINERY,
for all materials.
Write: PRATCHITT BROS., LTD.
ENGINEERS, CARLISLE.

MORRIS CRANES
Herbert Morris Ltd. Loughborough England

FLEXO
TINNING COMPOUND
CLEANS AND TINS ALL DIRTY METALS IN ONE OPERATION
THOMAS AND BISHOP LTD
37, TABERNACLE ST. LONDON. E.C.2.

Machine Cut Gear Wheels
THE REID GEAR CO.
1188
LINWOOD, near PAISLEY

ROBEY OF LINCOLN
for **RELIABILITY**
ROBEY & CO. LTD. LINCOLN


PRESSURE AND VACUUM GAUGES
David Harcourt Ltd.
COVENTRY RD. BIRMINGHAM, 10.

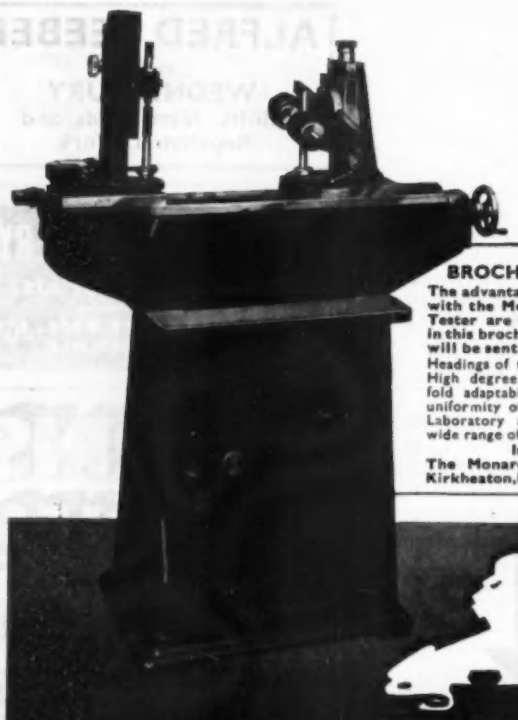
GWYNNES PUMPS

for

SEWAGE
DRAINAGE
DOCKS
WATERWORKS
IRRIGATION
DREDGING
MINING, etc.

All enquiries receive prompt and careful attention.

GWYNNES PUMPS LTD., HAMMERSMITH, W.6



BROCHURE G.T. 24

The advantages of testing gears with the Monarch No. 24 Gear Tester are fully demonstrated in this brochure, a copy of which will be sent free on request.

Headings of these advantages are: High degree of economy; Manifold adaptability; Sensitivity and uniformity of test; Suitability for Laboratory and Workshop and wide range of applicability.

Issued by
The Monarch Tool Co., Ltd.,
Kirkheaton, Huddersfield, Yorks.

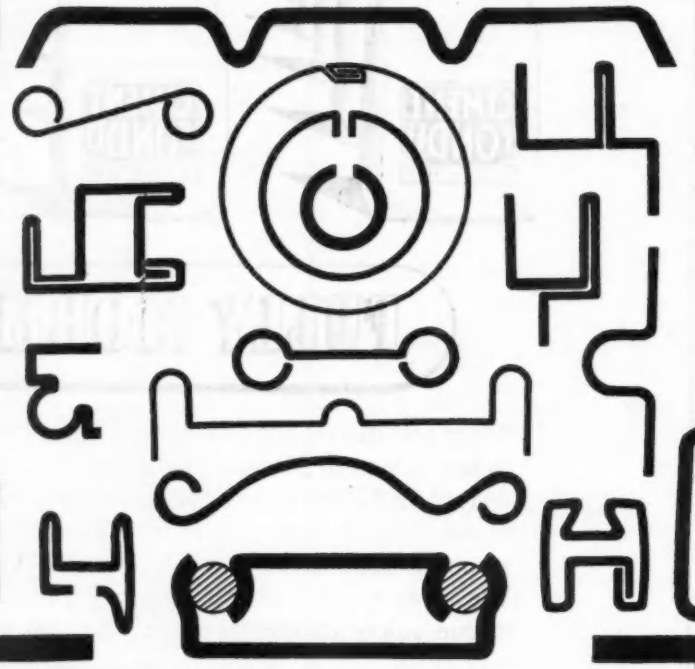
MONARCH
No TWENTYFOUR
GEAR TESTER

Manufactured by
MONARCH TOOL COMPANY, LTD.
KIRKHEATON,
HUDDERSFIELD.

GODINS

"THE ROLLERS OF STEEL SECTIONS" LTD.

Intricate Cold Rolled Formed Shapes are our Speciality.



We can produce any shape

NEWPORT, MON.
Telephone: Newport (Mon.) 4824.
Telegrams: Godins, Newport, Mon.

HIGH SPEED BLOWERS
Multi-blade, Rotary Type ***(Patent No. 410753)***
FOR AIR OR GAS.

Maximum Efficiency
Long Life **Silent Working.**
Can be used also as a Compressor or Exhauster.

THE BRYAN DONKIN CO., LTD.,
CHESTERFIELD
9813

Magnifying Thermometer

STRONG, ACCURATE and RELIABLE.

MADE IN MANY VARIETIES
TO SUIT ALL PURPOSES

Adopted with advantage in connection with **Steam Plants** (Superheaters, Economisers, &c.) also **Sugar Refiners, Gasworks, Breweries, Heating Plants, Baths, &c., &c.**

State your requirements and write for prices to— 772

T. SUGDEN, Ld.,
Bush House, Aldwych, LONDON, W.C.2.
Telephone: Temple Bar 3079. Telegrams: Tubularity, Phone, London.

Your Men will STAY on the JOB
till the BOMBS begin to DROP if they know they can dive to SAFETY in:

The ANDAMITE "RAIDSAFE"

Outstanding Points:

1. Blast and splinter proofed by 12in. of reinforced concrete.
2. **Can be placed in shop so that four men can be under cover in ten seconds.**
3. No permanent obstruction of floor space.
4. Tremendous debris loading.
5. No excavation or building.
6. No sandbags or other secondary strengthening required.

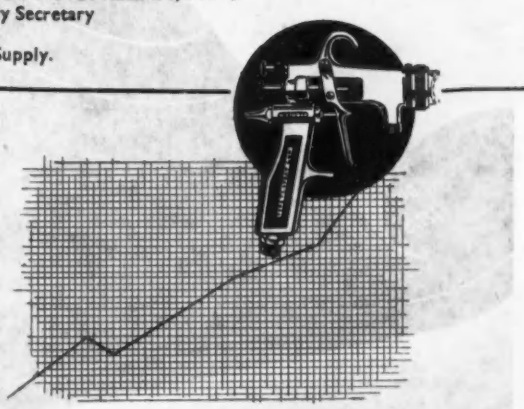
The Managing Director of a leading Industrial Concern writes: *"The shelter has proved a great success and it has inspired the greatest possible confidence in the men concerned, who continue working day and nihgt whatever may be happening around them."*

For 4 Persons . £54 10s. 0d. ex works Extensible per 2 persons . £9 10s. 0d.
Weight approx. 6½ tons. Each additional section 1½ tons.
Write now for full description.

ANDAMITE LTD.
CONTRACTORS AND VENTILATION ENGINEERS.
52 Ebury St., London, S.W.1. *Telephone: Sloane 7077 & 5688.*

"VICTORY DEPENDS UPON OUR CAPACITY FOR PRODUCTION"

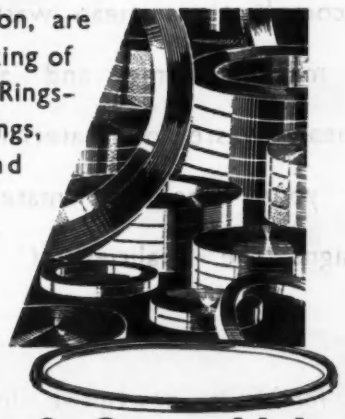
Mr. HAROLD MACMILLAN, M.P.,
Parliamentary Secretary
to the
Ministry of Supply.



SPEED UP WITH
AEROGRAPH
SPRAY PAINTING & FINISHING EQUIPMENT
Write for literature to The Aerograph Co. Ltd., Lower Sydenham London, S.E.26. Tel.: Sydenham 6060 (8 lines)
CVS—193

Weldless
FORGED STEEL RINGS & BLANKS OF EVERY SIZE & DESCRIPTION.
Also
Welded **RINGS OF ALL TYPES**

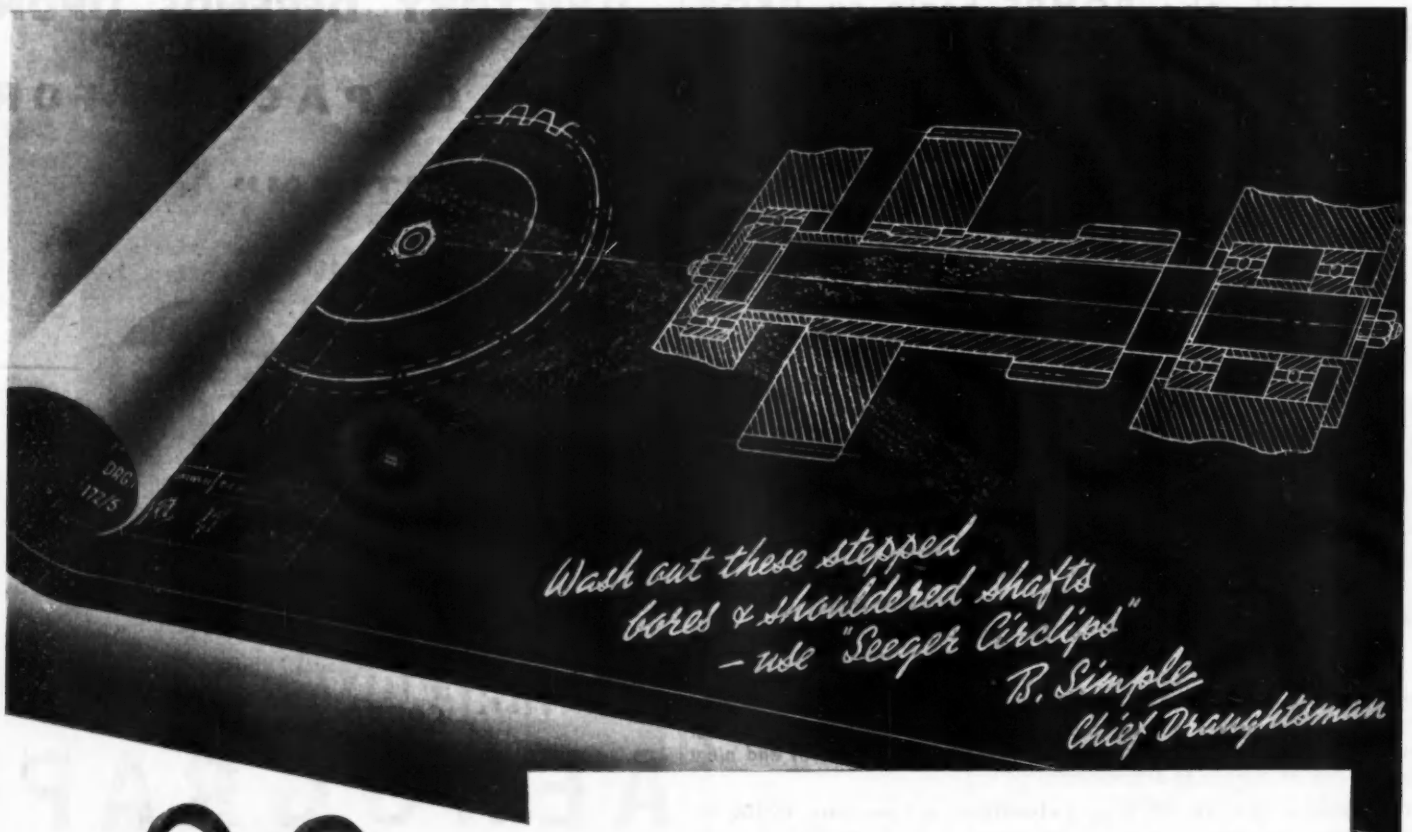
Hingley's, of Netherton, are specialists in the making of Welded and Weldless Rings- in addition to Forgings, Drop Forgings and Smith Work.
Send an enquiry and prove the value of Hingley's service for yourself.

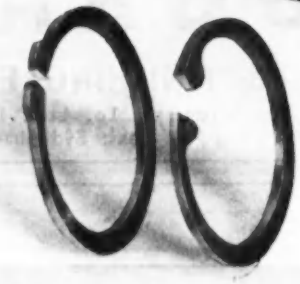


N. Hingley & Sons Ltd
NETHERTON IRON WORKS : DUDLEY

FOR THEIR METAL PARTS WASHING MACHINERY
"Dawson" WAS CHOSEN!
The leading British Engineers have installed DAWSON machines for metal parts washing. Send for catalogue. DAWSON BROS. LTD., Ventnor Wks. Gomersal Leeds

Dawson METAL PARTS
WASHING MACHINERY
London Address: Roding Lane, Southend Road, Woodford Green, Essex.





EXTERNAL TYPE INTERNAL TYPE

SEEGER PATENT CIRCLIPS

Why use stepped bores and shoulder shafts?

A Seeger Circlip makes a better job and only calls for the machining of a simple groove.

Unnecessary complications mean waste of drawing office time, machine time, and assembly time. They also mean waste of material. Let Seeger Circlips save your time and material and give to your designs the qualities of simplicity and economy.

Write for fully descriptive literature.

Manufactured by The AUTOMOTIVE ENGINEERING Co LTD The Green, Twickenham, Middx.

Smee's

OAKEY'S

Wellington

EMERY, CARBORUNDUM & WELLINGTONITE CLOTH

Sheets, Coils, Rolls, Discs and Belts.

REINFORCED DISCS

for use with all types of Flexible Sanders.

EMERY GRAIN

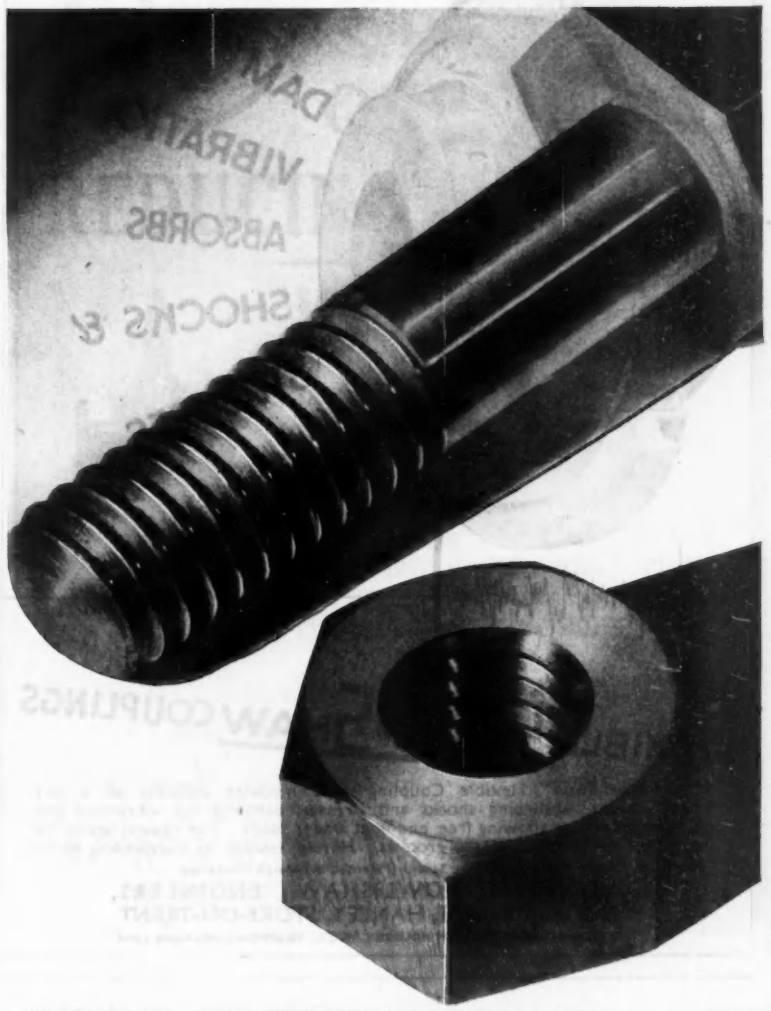
• **Prove Oakeys for yourself** •

JOHN OAKEY & SONS, LIMITED,
Wellington Mills, London, S.E.1.
Telephone: WATerloo 4206. Telegrams: "Oakey, Lamb, London."

DRILLING & BORING SPECIALISTS

12' 0" MACHINE ILLUSTRATED WITH 40" RADIAL ON BASEPLATE.

KITCHEN & WADE LTD., HALIFAX — YORKS



"MARWIN SUPATUFF"

High-Tensile

BOLTS & NUTS

"MARWIN SUPATUFF" High Tensile Bolts are Heat treated to withstand abnormal shock and strain. Shanks and faces are machined and ground to fine limits, and the accuracy and strength of these bolts are guaranteed.

You are invited to write for our current price lists; we are actual manufacturers of high class bolts, nuts, set pins, studs, etc., in mild, high carbon and alloy steels and specialise in big sizes. Deliveries from stock.

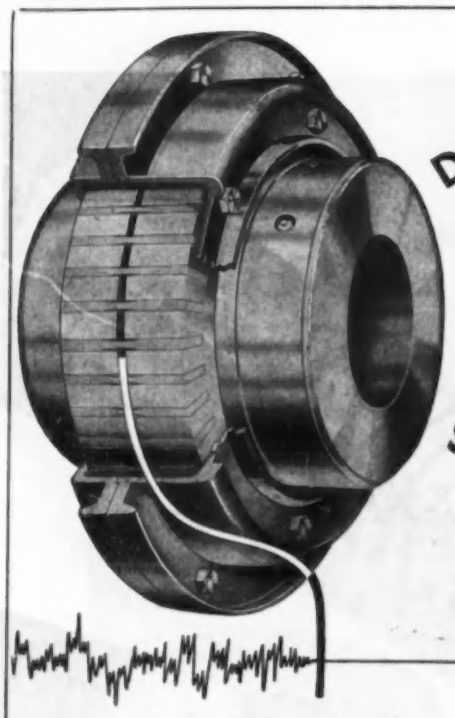
MARWIN

W. MARTIN WINN LTD.

- - *STATION WORKS* **DARLASTON**

Telephone: DARLASTON 72 (5 lines). *London Agent: W. R. Volrath,*
Telegrams: ACCURACY, DARLASTON. *42, Ellerby Street, Fulham, S.W.6.*

dm 350



DAMPS VIBRATIONS ABSORBS SHOCKS & STRESSES

FLEXIBLE STEEL-SHAW COUPLINGS

The "Steel-Shaw" Flexible Coupling accommodates instantly all errors in alignment, absorbing shocks and stresses, damping out vibrations and at the same time allowing free end-float under loads. The reason lies in the design of the springs and the grooves. Herein resides its outstanding merit

Patent Number 346641 (Patented in Foreign Countries)

STEELE & COWLISHAW, ENGINEERS,
COOPER STREET, HANLEY, STOKE-ON-TRENT. 1231

LONDON OFFICE: 329, HIGH HOLBORN, W.C.1. TELEPHONE: HOLBORN 1695

JET INSTRUMENTS

— LOW FIRST COST — EASY INSTALLATION
— NO MAINTENANCE.

Illustrations show Typical Examples of the large Range Available for

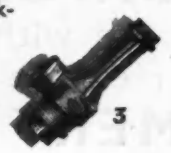
1

1. Raising and discharging liquids or solids in suspension.
2. Mixing heating and circulating fluids. Steam, Air or Water Operated.
3. Elevating and heating liquids for all industrial processes.
4. Exhausting condensers and other large closed vessels, and for priming pumps.
5. Entraining and forcing air or gases against moderate back-pressures.

5

4

2


3

GRESHAM & CRAVEN LTD

ORDSALL LANE SALFORD-MANCHESTER-5

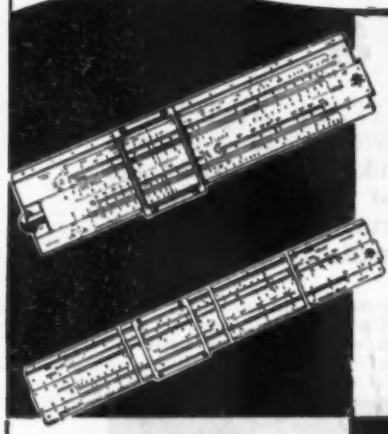
Phone No.: BLAckfriars 4316. MANUFACTURERS. Telegrams: Brake Phone, Manchester.

London Office: 14, GREAT PETER ST., WESTMINSTER, LONDON, S.W.1.

Thornton's

WORLD-FAMOUS

SLIDE RULES & INSTRUMENTS



P.I.C. SLIDE RULES

with Patent Differential Scales

The P.I.C. Rules with patent Differential Scales are the most sensational contribution to Slide Rule Art of this generation. Write for special descriptive matter.

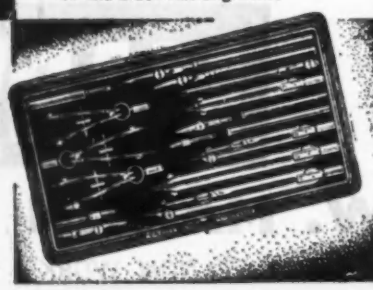
P.I.C. A.C. ELECTRICAL SLIDE RULES

The P.I.C. Patent A.C. Electrical Slide Rule introduces a new system of Trigonometrical and other Scales specially designed for electrical calculations. The Rule demonstrates a striking advance in Slide Rule technique for the Electrical Engineer.

DRAWING INSTRUMENTS

Thornton's drawing and surveying instruments are renowned for their accuracy and reliability — other manufactures include, Drawing Boards, Tee and Set Squares, Scales, Curves, etc.

Descriptive Booklet Series D17 Post Free

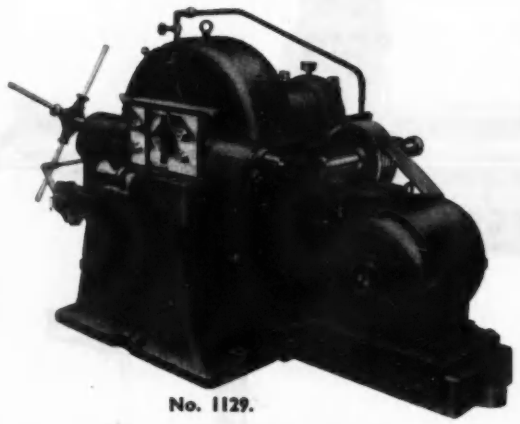


A. G. THORNTON LTD

Paragon Works, King St. West, Manchester 3

TAYLOR CUTTING-OFF MACHINES

FOR BARS AND TUBES IN FERROUS AND NON-FERROUS METALS



No. 1129.

FASTEST MACHINE MADE

EASIEST TO OPERATE

CHEAPEST TO MAINTAIN

MADE IN TWO SIZES.

No. 1 FOR BARS AND TUBES UP TO 3 in. DIAM.

No. 2 FOR BARS UP TO 4½ in. DIAM. OR TUBES UP TO 6½ in. OUTSIDE DIAMETER

ACTUAL CUTTING TIMES

3 in. MILD STEEL BAR CUT-OFF IN	20 SECONDS
2 in. GAS TUBE CUT-OFF IN	7 SECONDS
4½ in. MILD STEEL BAR CUT-OFF IN	50 SECONDS
3½ in. COPPER TUBE (3 in. BORE) CUT-OFF IN	18 SECONDS

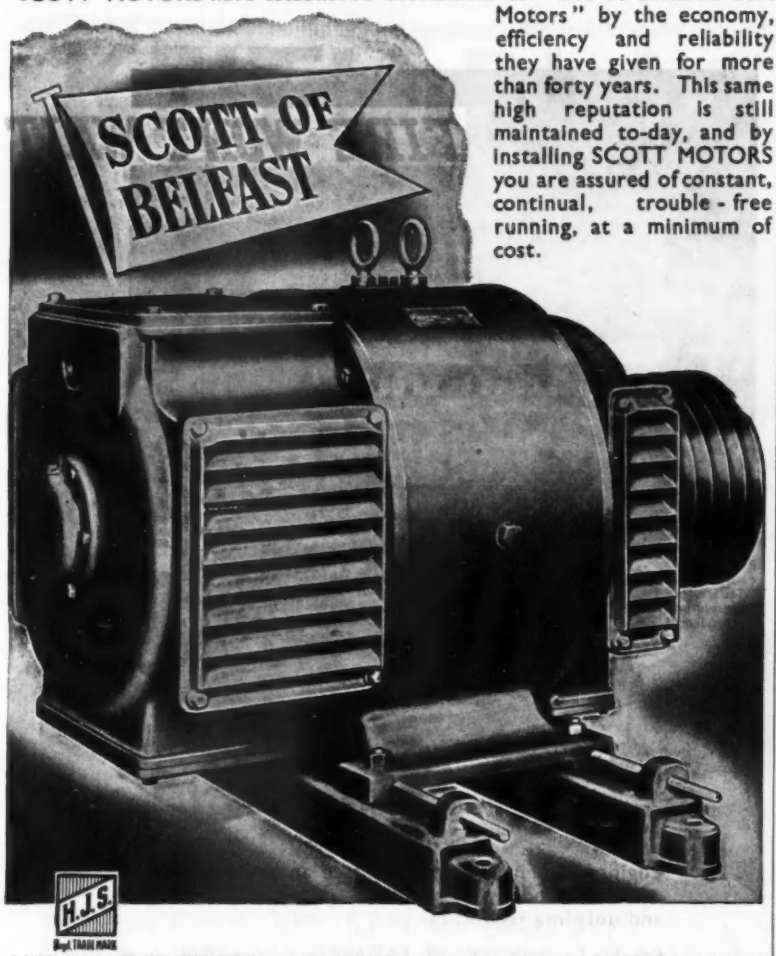
BOTH MACHINES ARE SUPPLIED WITH BELT OR DIRECT ELECTRIC DRIVE.

THESE MACHINES ARE FITTED WITH AN AIR-OPERATED VICE WHEN REQUIRED.

ASK FOR SECTION II.T. CATALOGUE

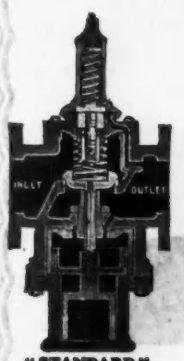
CHARLES TAYLOR (BIRM) LTD. BIRMINGHAM 5 ENGLAND

SCOTT MOTORS have established themselves as "one of Britain's best Motors" by the economy, efficiency and reliability they have given for more than forty years. This same high reputation is still maintained to-day, and by installing SCOTT MOTORS you are assured of constant, continual, trouble-free running, at a minimum of cost.



HUGH J. SCOTT & CO. (Belfast) LTD., N. IRELAND

CROSBY RELAY OPERATED REDUCING VALVES



"STANDARD" For Steam or Air.

SELF-CONTAINED AND SEPARATE RELAY TYPES.

THE SELF-CONTAINED TYPE, KNOWN AS THE "MASON STANDARD," DOES NOT REQUIRE WATER OR COMPRESSED AIR TO OPERATE.

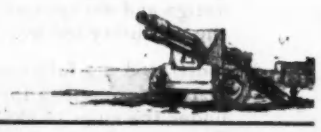
OUR SPECIALITIES INCLUDE:—
SURPLUS and MAKE-UP VALVES, PUMP GOVERNORS, FEED PUMP CONTROLS, DE-SUPERHEATERS, TEMPERATURE CONTROLS, ETC.

REDUCING VALVES FOR ALL PRESSURES UP TO 2000 LBS. PER SQ. IN.

Ask for free pamphlets GE 1180 and KE 1311, describing reducing valves. Literature regarding other specialities sent free on request. 807

CROSBY VALVE & ENGINEERING CO., LTD.
251, EALING ROAD, WEMBLEY, MIDDLESEX.

GUNS



TANKS

AEROPLANES

LORRIES

The screw that cuts its own standard machine screw thread

Whatever you are manufacturing, the "Shakeproof" thread cutting screw will save time, labour and production cost. By the single operation of drilling a hole and inserting a "Shakeproof" screw, with the power of an ordinary screw driver, a better and more secure method of fastening metal parts is obtained without the use of Taps. In the interest of cheaper and speedier assembly with increased efficiency you should write for a free demonstration kit and literature.

"SHAKEPROOF"
(TRADE MARK)
THREAD-CUTTING SCREWS

BARBER & COLMAN LTD.—MARSLAND ROAD—BROOKLANDS
MANCHESTER—TEL.: SALE 2277 (2 LINES). GRAMS.: "BARCOL" SALE

WELDED TANKS and VESSELS

In Steel, Stainless Steels, Aluminium, etc., etc.

Robert Jenkins & Co. Ltd.
IVANHOE WORKS ROTHERHAM
Estd. 1856

Telephone: 584 (3 lines). Telegrams: Jenkins, Rotherham.
LONDON OFFICE: 149-151 ABBEY HOUSE, VICTORIA STREET, LONDON, S.W.1.

Natural Ventilation without downdraught

The provisions of the Factory Acts demand the efficient ventilation of industrial buildings.
Natural ventilation is certainly the most economical and, by the use of 'Handcraft' Aerolete Asbestos-Cement Extractor Ventilators, can be the most efficient and reliable system.
These ventilators function by virtue of the induced up-draught brought about by increasing curvature of the louvres combined with the extractive effect of the head. Downdraught is entirely eliminated. 'Handcraft' Aerolete Asbestos-Cement Extractor Ventilators are, under normal circumstances, everlasting. They do not require painting or attention, they are non-corrosive and actually get stronger with age. *Write for leaflet L19.*

HANDCRAFT 'AEROLETE'

ASBESTOS-CEMENT EXTRACTOR VENTILATORS

UNIVERSAL ASBESTOS MANUFACTURING CO. LTD.
Handcraft Works, Tolpits Lane, Watford.
Phone : Watford 3371-3.

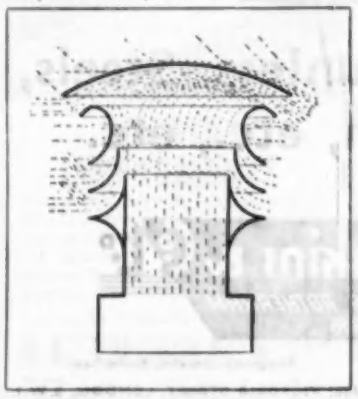
BRANCHES :

BIRMINGHAM :
153a, Corporation Street.
Telephone : Central 5949.

MANCHESTER :
Royal London House,
196 Deansgate.
Telephone : Blackfriars 2466.

GLASGOW :
136, Nithsdale Drive,
Strathbungo, Glasgow, S.1.
Telephone : Pollock 2266.

BRISTOL :
51, Broad Street.
Telephone : Bristol 20737



SIZES

Height	Internal Diam.
20 in.	6 in.
39 ,,	9 ,,
46¾ ,,	12 ,,
61½ ,,	18 ,,
68½ ,,	24 ,,

Patent Nos.
467,613 463,708
476,029 463,690

74-14

Photo by courtesy of "The Sheffield Telegraph and Independent."

Engines for Fire Pump Duty face an exacting service which demands two essentials — instantaneous starting and unfailing reliability.

Fowler-Sanders Diesel Engines are specified with confidence for Fire Pump Duty. The patented "Two-Way Swirl" Combustion Chamber ensures certain quick starting in all weather conditions. Advanced design and exceptional robustness have made possible the reliability for which they are renowned.

Illustrated is a fully automatic fire pump by Mather & Platt Ltd., supplied for use with sprinkler installations under the rules of the Fire Offices' Committee. The Engine is a Fowler-Sanders High Speed Diesel. Output of pump 1,000 gallons per minute.

PETROL ENGINES from 1½ to 16 B.H.P. DIESELS from 4 to 200 B.H.P.

JOHN FOWLER & CO. [LEEDS] LTD. LEEDS. 10.
Telephone: Leeds 21641-4. Telegrams: 'FOWLER' Leeds

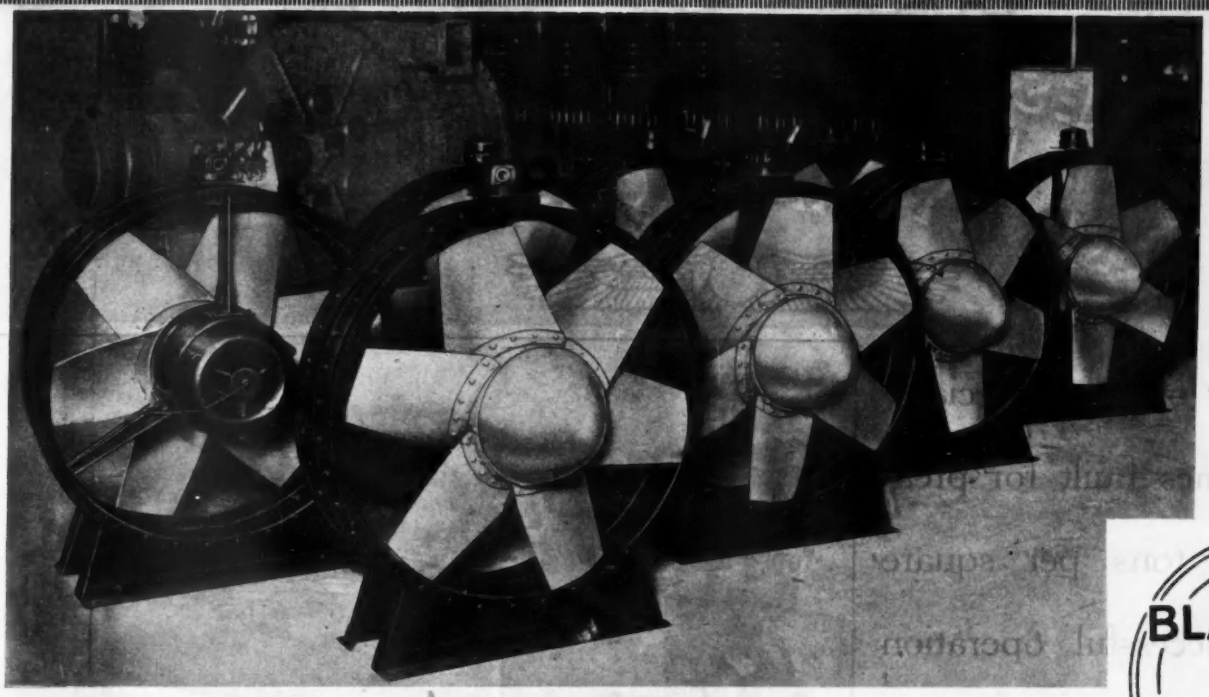
Before **YOU GET STUCK FOR STEAM**
OWING TO
FUEL RESTRICTIONS
GET IN TOUCH WITH
THE TURBINE FURNACE CO.
WHO MAY BE ABLE TO
HELP YOU

TURBINE FURNACES will burn any class and size of Fuel.

THE TURBINE FURNACE CO., LTD.
238b, Gray's Inn Rd., London, W.C.1.
Telephone : Terminus 4365

KEITH BLACKMAN FANS

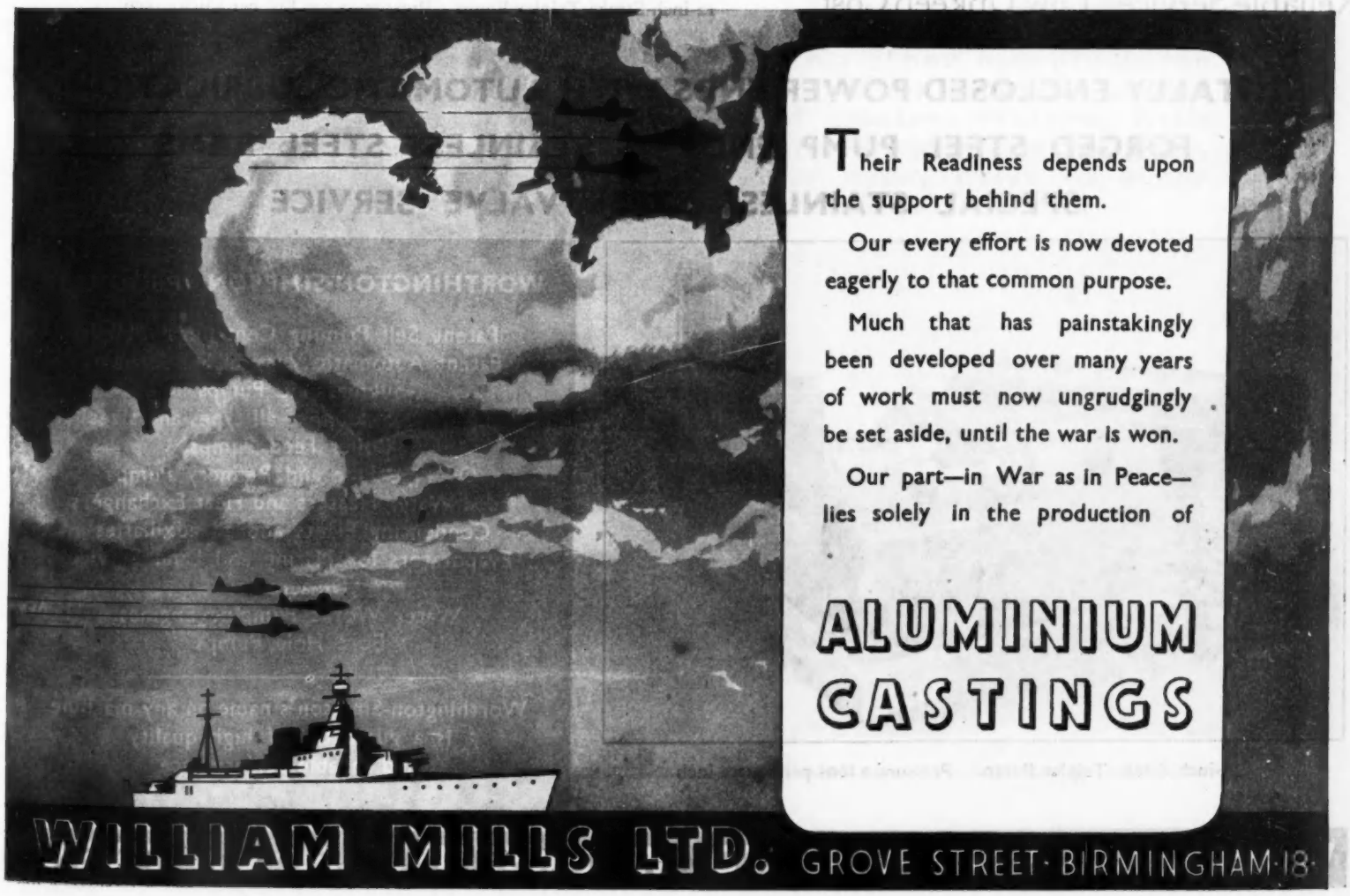
AIR DUCTS, WASHERS, HEATERS & FILTERS : SUCTION HOODS & DUST SETTLERS



These "Blackman" Anti-clastic Propeller Fans are axial-flow type designed for work hitherto done by centrifugal fans, work which involves the movement of considerable quantities of air against moderate resistance, through trunking, etc. With them simpler ductwork is permissible, with consequent lower first and running costs, due to lower pressure losses.

If it's HEATING, VENTILATION, DUST EXHAUST, INDUCED DRAUGHT, DRYING FUMES REMOVAL, FORGE BLOWING, CUPOLA BLAST, FURNACE BLOWING, —or any other proposition involving movement of AIR or GASES consult us.

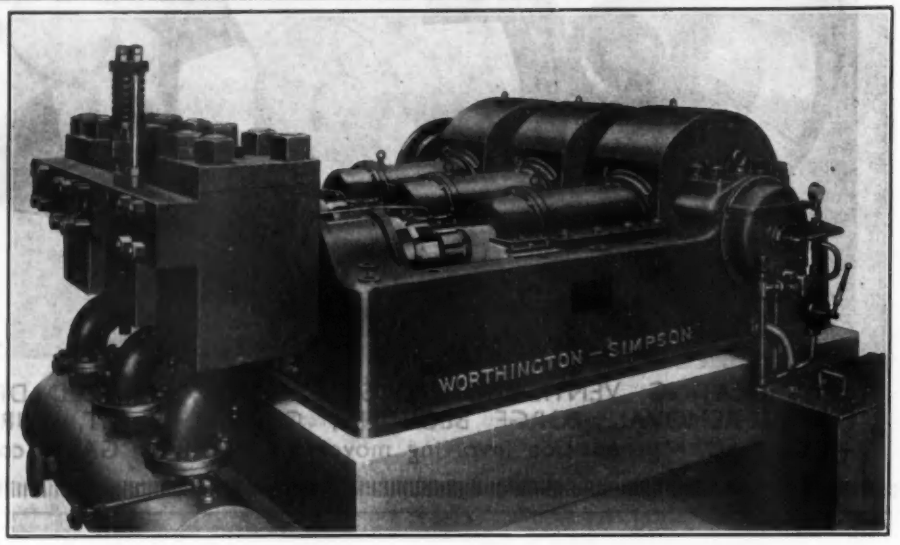
KEITH BLACKMAN LTD.
MILL MEAD ROAD, LONDON, N.17.
'PHONE: TOTTENHAM 4522
'GRAMS: KEITHBLAC, PHONE, LONDON."


Their Readiness depends upon the support behind them.
Our every effort is now devoted eagerly to that common purpose.
Much that has painstakingly been developed over many years of work must now ungrudgingly be set aside, until the war is won.
Our part—in War as in Peace—lies solely in the production of
ALUMINIUM CASTINGS
WILLIAM MILLS LTD. GROVE STREET · BIRMINGHAM 18

WORTHINGTON-SIMPSON

HEAVY PRESSURE TRIPLEX POWER PUMPS FOR EXTRUSION AND HYDRAULIC PRESSES

A large number of these specially designed machines built for pressures up to 3 tons per square inch, are in successful operation in this country and abroad. Robust Construction—Long and Reliable Service—Low Upkeep Cost

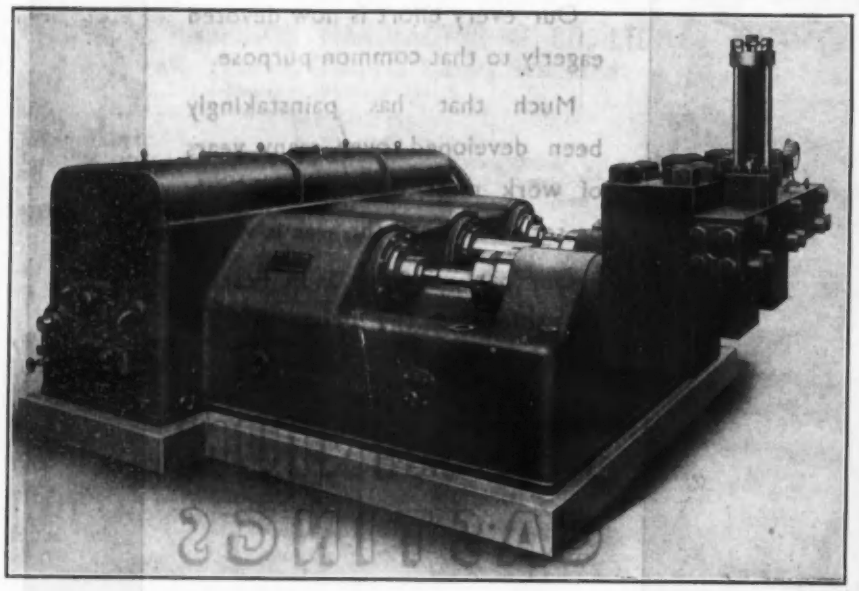


12-inch Stroke Triplex Pump. Pressure 3,530 lbs. per square inch.

TOTALLY ENCLOSED POWER ENDS WITH AUTOMATIC LUBRICATION

FORGED STEEL PUMP ENDS STAINLESS STEEL RAMS

SPECIAL STAINLESS STEEL VALVE SERVICE



15-inch Stroke Triplex Pump. Pressure 2 tons per square inch.

WORTHINGTON-SIMPSON PRODUCTS

Patent Self Priming Centrifugal Pumps
Patent Automatic Vertical Self Priming Submersible Pumps
Centrifugal Pumps—all types and sizes
Boiler Feed Pumps
Oil Pipe Line and Refinery Pumps
Feed Water Heaters and Heat Exchangers
Condensing Plants and all auxiliaries
Evaporators for Marine and Land Service
De-aerators
Water Works Pumping Engines
Bore Hole Pumps

Worthington-Simpson's name on any machine is a guarantee of high quality and reliable performance

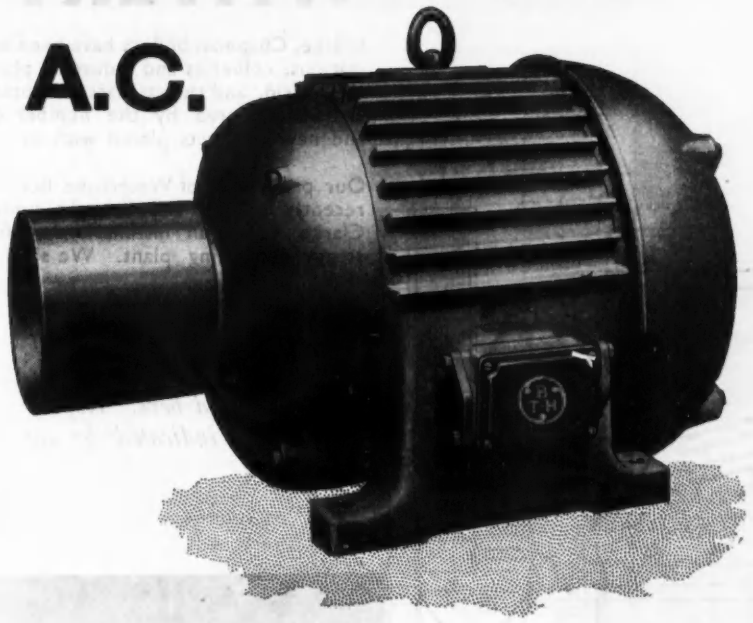
WORTHINGTON-SIMPSON, LTD., WORKS:- NEWARK-ON-TRENT

B T-H

TOTALLY-ENCLOSED FAN-COOLED

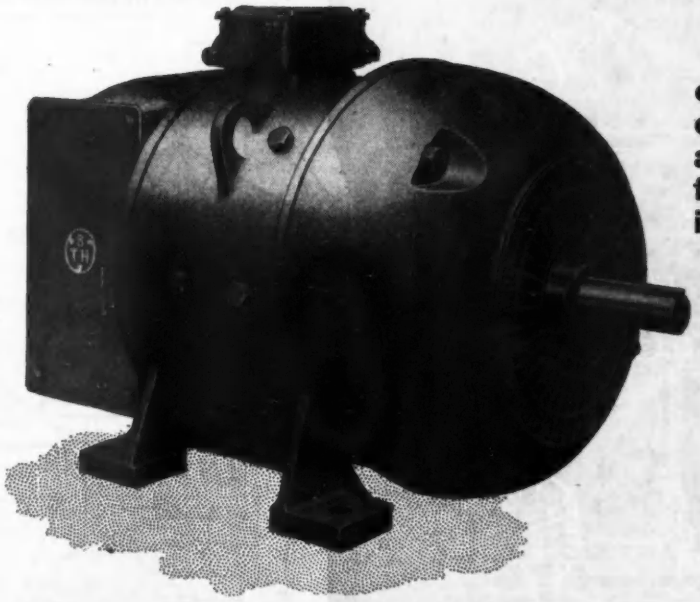
MOTORS

A.C.



For use in exposed positions or in dusty, moisture-laden, and corrosive atmospheres.

D.C.



No other manufacturer can offer a wider choice of electric motors, with appropriate control gear, for every drive in every industry.

• •

Send us your enquiries.

BTH **RUGBY**

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED, RUGBY, ENGLAND. A 2908

The deep experience of years of boiler production is the solid foundation to the success of CLARKE·CHAPMAN

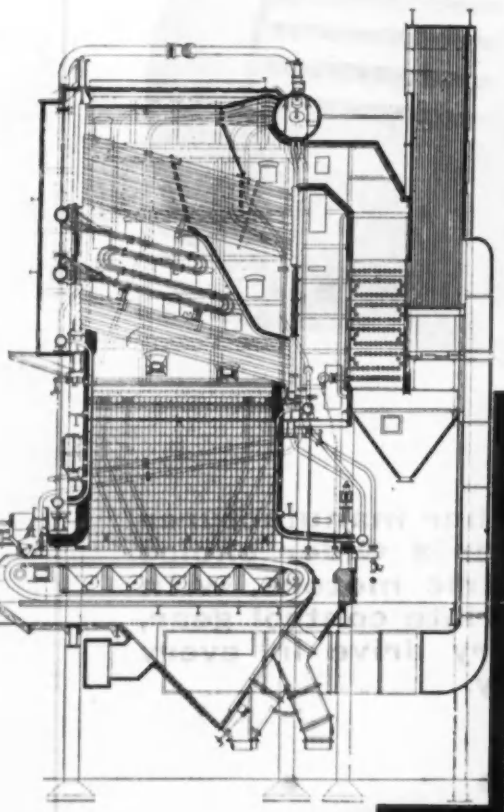
WATERTUBE *Boilers*

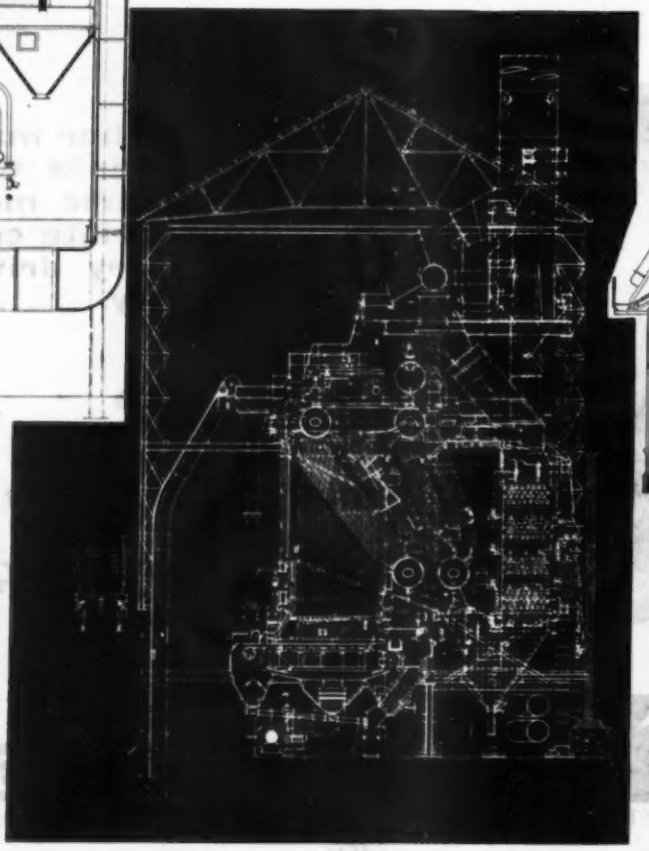
Clarke, Chapman boilers have been installed in power stations, collieries and industrial plants in all parts of the world, and the satisfaction obtained by their use can be measured by the number of repeat orders and new contracts placed with us.

Our production of Watertube Boilers is summarised in our Catalogue No. 77D, which has been recently revised and brought up-to-date. Profusely illustrated with sectional drawings of Clarke, Chapman installations, this publication is worthy of study by anyone interested in steam generating plant. We shall be pleased to send you a copy post free, on your request.

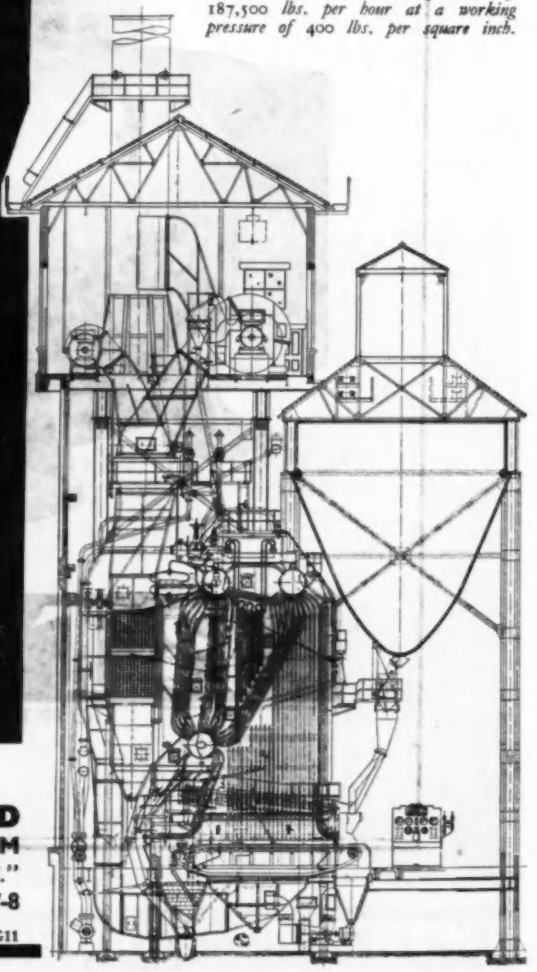
★ *Some of our more recent home installations of Watertube Boilers include those tabulated here. Repeat orders are indicated by an asterisk.*

Purchaser.	Evaporation per Boiler.	No. of Boilers.
Portsmouth Corporation	150,000 lbs/hr.	2
Edinburgh ,,	120,000 lbs/hr.	2
Hull ,,	100,000 lbs/hr.	5
* ,, ,,	187,500 lbs/hr.	2
* ,, ,,	187,500 lbs/hr.	1
Sunderland ,,	110,000 lbs/hr.	2
Dunston "B" Power Station	156,000 lbs/hr.	6
,, ,, ,, ,,	125,000 lbs/hr.	2
* ,, ,, ,, ,,	156,000 lbs/hr.	1
Slough Estates Ltd.	30,000 lbs/hr.	4





LEFT.—One of two Clarke, Chapman Tri-Drum Watertube Boilers, each with a maximum continuous evaporation of 187,500 lbs. per hour at a working pressure of 400 lbs. per square inch.



TOP.—One of four Clarke, Chapman Header Type Watertube Boilers, fitted with Superheater, Economiser, Air Heater and Mechanical Stoker as installed in a large Electric Power Station in the County of Durham.

Evaporation, 156,000 lbs. per hour each boiler.
Working Pressure, 625 lbs. per sq. inch.

RIGHT.—One of Clarke, Chapman Four-Drum Watertube Boilers supplied to a large Electricity undertaking.

Evaporation, 80,000 lbs. per hour.
Working Pressure, 250 lbs. per sq. inch.
Heating Surface, 11,530 sq. ft.

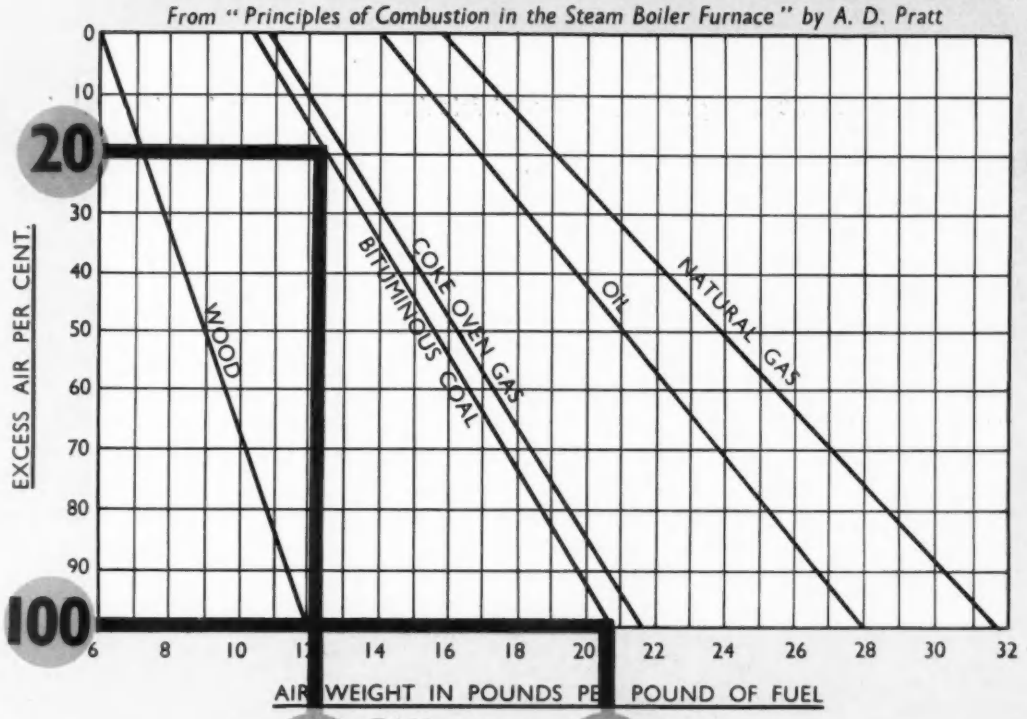
CLARKE, CHAPMAN & COMPANY, LIMITED
VICTORIA WORKS . . GATESHEAD 8 . . CO. DURHAM
Telephones: Gateshead 72271 (6 lines). *Telegraphic Address: "Cyclops, Gateshead."*
London Office: Fenton House, 112-3, Fenchurch Street, E.C.3. Tel. Royal 2737-8

EG11

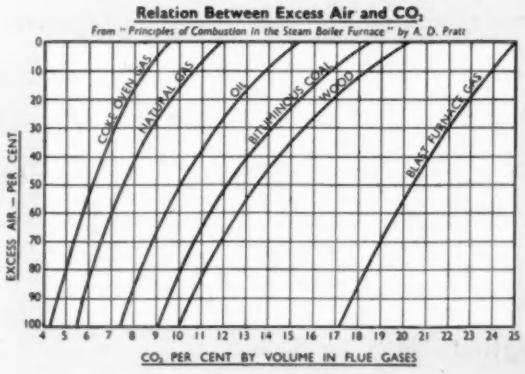
WHAT DOES CO_2 MEAN?

Relation Between Excess Air and Air Weight

From "Principles of Combustion in the Steam Boiler Furnace" by A. D. Pratt



(For convenience we reproduce below the chart from the first advertisement of this series.)



OUR first advertisement of this series showed that in effect CO_2 percentage was without meaning as a measure of combustion efficiency unless the analysis of the fuel was known, whereas the percentage of excess air provided a measure which was independent of the type of fuel.

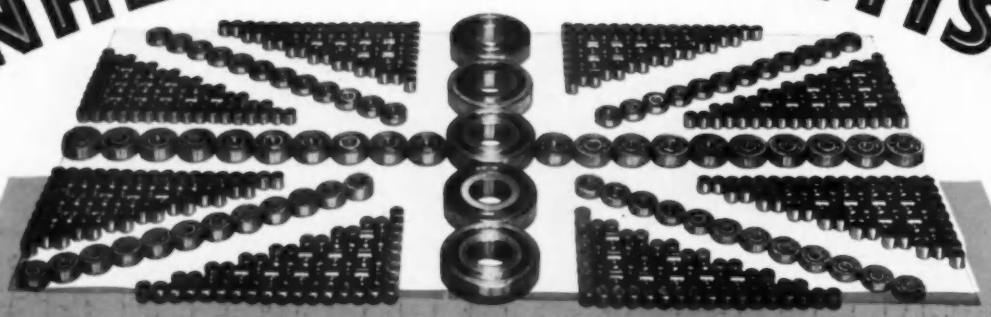
It will be seen from the chart above that with Bituminous Coal each 10% increase in excess air means an increase of approximately 1 lb. of air for combustion per pound of coal, or between 20% excess air (15.4% CO_2) to 100% (9.1% CO_2), there is an increase of 8.4 lb. of air per pound of coal, i.e. 112 cubic feet at 70°F. and atmospheric pressure.

This unnecessary loading of the forced draught fan motor is obviated by the use of Bailey water cooled furnace construction, which permits minimum excess air to be carried over a very wide range of load.

This is the second of a series of three advertisements

BABCOCK & WILCOX LTD. 34 FARRINGDON STREET LONDON, E.C.4

INHERENTLY BRITISH



We were amongst the pioneers of anti-friction bearing design in Britain,

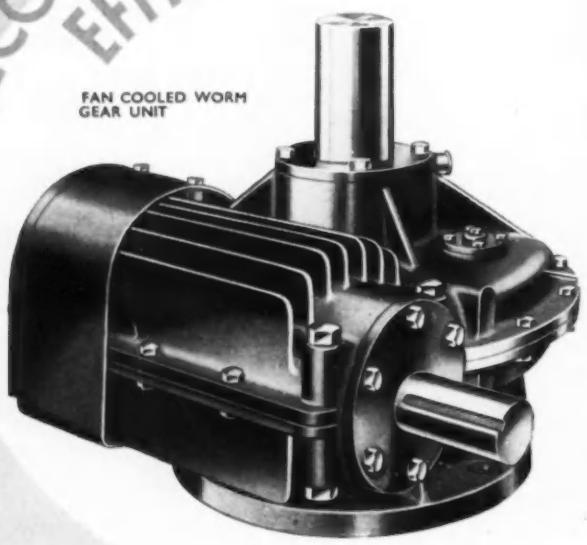
HOFFMANN BEARINGS

being first made over 40 years ago. From that time forward, our energies have been bent on the furthering of bearing design and application.
Few fundamental changes in the original designs have been made, proving that these were based upon sound and enduring principles. Correct design is supported by the use of ideal materials wrought with characteristic British thoroughness.
Hoffmann Bearings are the natural choice where reliability is the paramount consideration.

BRITISH DESIGN
BRITISH MATERIALS
BRITISH WORKMANSHIP

THE HOFFMANN MANUFACTURING COMPANY LTD. CHELMSFORD, ESSEX

ECONOMIC EFFICIENCY



FAN COOLED WORM GEAR UNIT

MOSS GEARS

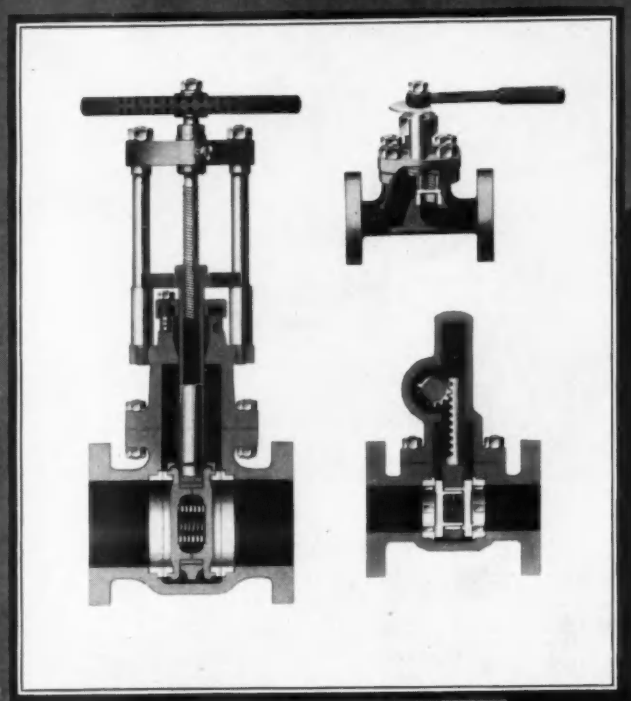
● The MOSS GEAR range of Gear Units forms a complete group for every industrial transmission need. All gears are accurately cut and hobbed, all joints are perfectly oil-tight, and special features exclusive to Moss Gears give greater cooling where it's most needed.

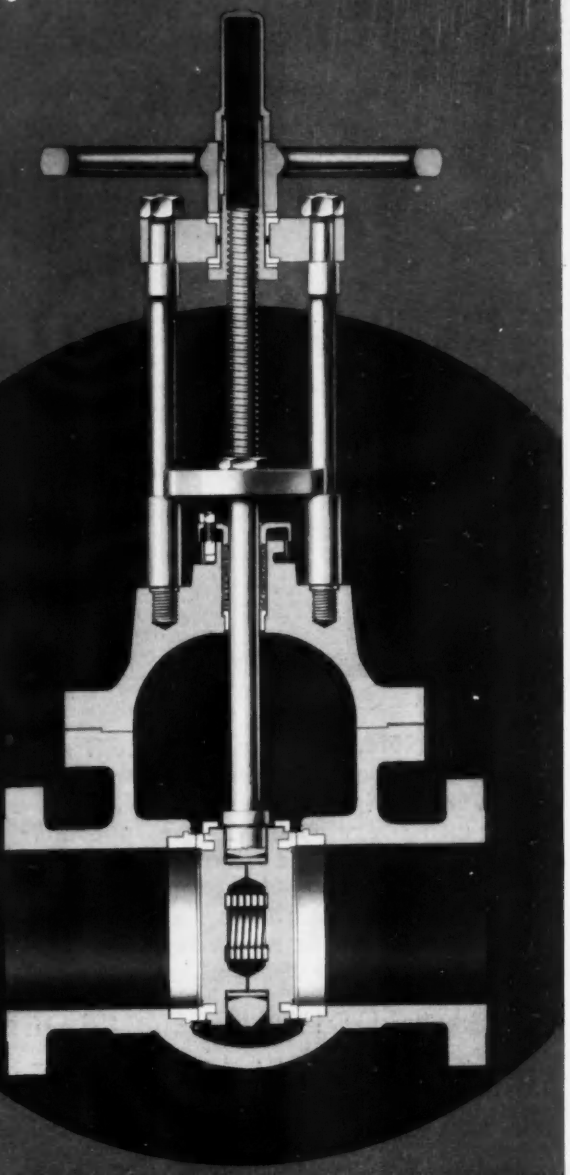
Standard, vertical and inverted types can be supplied.

THE MOSS GEAR Co. LTD
CROWN WORKS · TYBURN
BIRMINGHAM 24
'PHONE · ERDINGTON 1661-2-3-4
'GRAMS · MOSGEAR B'HAM

HOPKINSONS' *Patent*

PARALLEL SLIDE VALVES





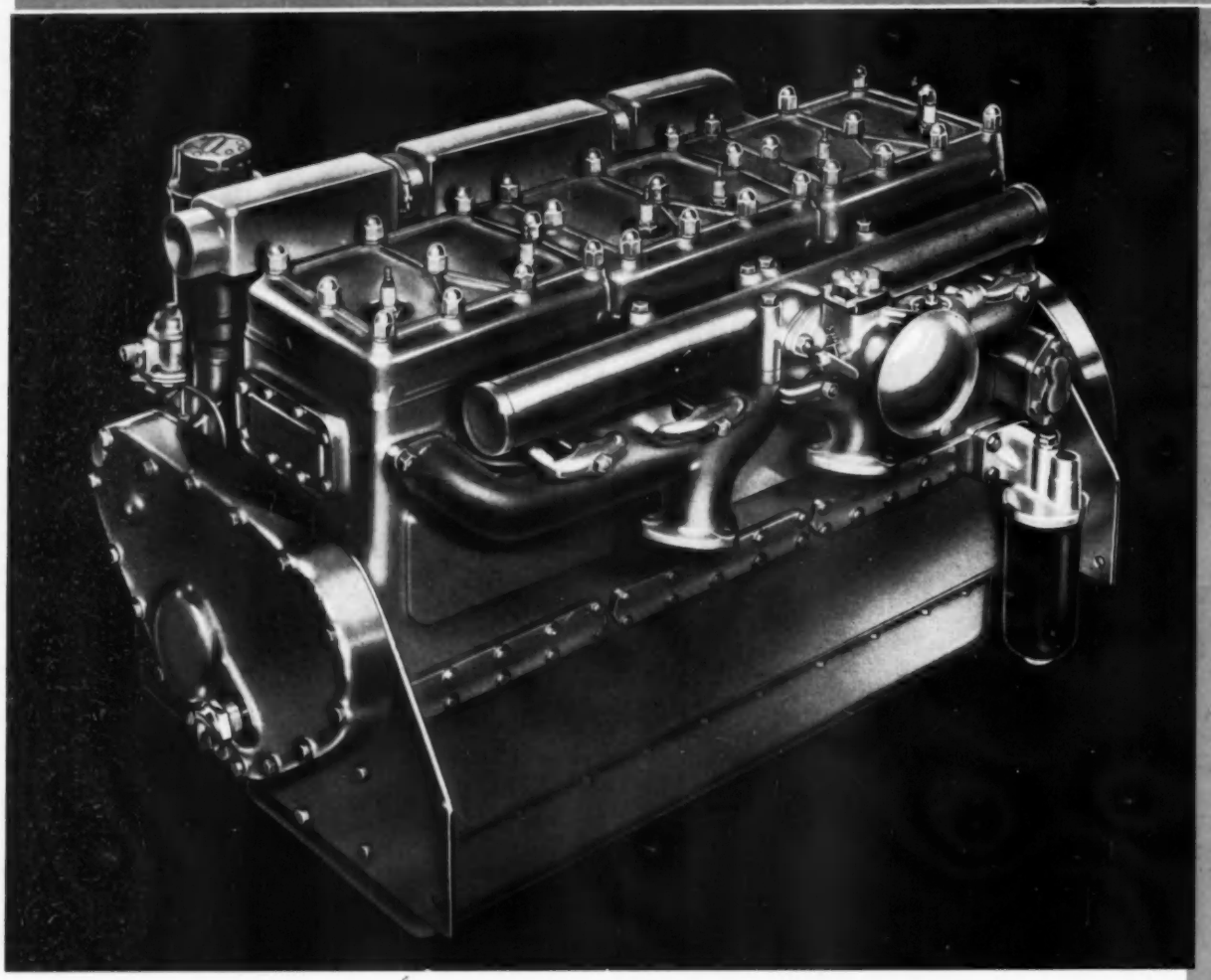
FOR ALL PRESSURES AND TEMPERATURES

AVAILABLE IN STEEL, IRON AND BRONZE

HOPKINSONS LIMITED

A519/3251

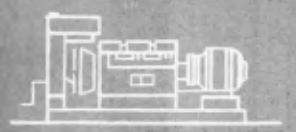
Master Builders of Industrial Engines



COVENTRY CLIMAX · GODIVA · ENGINES LTD

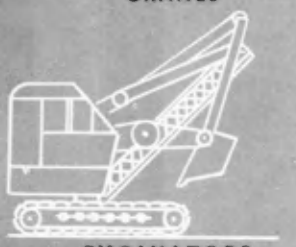
Suitable for all applications including —

TRACTORS



GENERATOR SETS

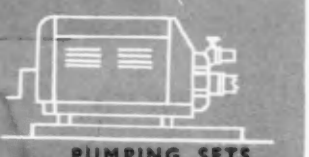
CRANES



EXCAVATORS

FIRE ENGINES

ARMOURED CARS



PUMPING SETS

COVENTRY CLIMAX were one of the first and are still the leading heavy-duty engine builders in a city famous the world over for fine engineering. Backed by 36 years experience and development the present series of "GODIVA" Industrial engines is characterised by "designed-in" reliability, robustness and endurance down to the last detail. They offer a reliable and economical source of power for a wide range of heavy duty equipment applications.

3 TYPICAL "GODIVA" PETROL ENGINES

TYPE F.A.6 (illustrated above) Six cylinder. Capacity 6,754 c.c. developing 135 H.P. at 2,500 R.P.M. Overall size: Width 25½ in. Height 25½ in. Length 43 in. including flywheel housing.

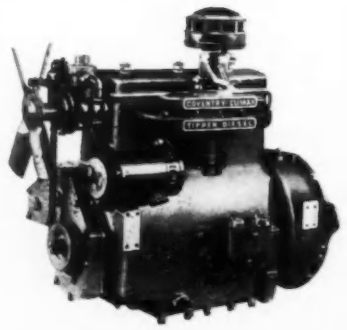
TYPE F.A. Four cylinder. Capacity 3,933 c.c. developing 80 H.P. at 2,600 R.P.M. Overall size: Width 24 in. Height 28½ in. Length 32⅜ in. including flywheel housing.

TYPE Z. Four cylinder. Capacity 1,911·4 c.c. developing 50 H.P. at 3,250 R.P.M. Overall size: Width 20½ in. Height 25 in. Length 28 in. including flywheel housing.

Complete particulars and performance data from COVENTRY CLIMAX ENGINES LTD. (Dept. W), COVENTRY

A CLIMAX-TIPPEN DIESEL ENGINE

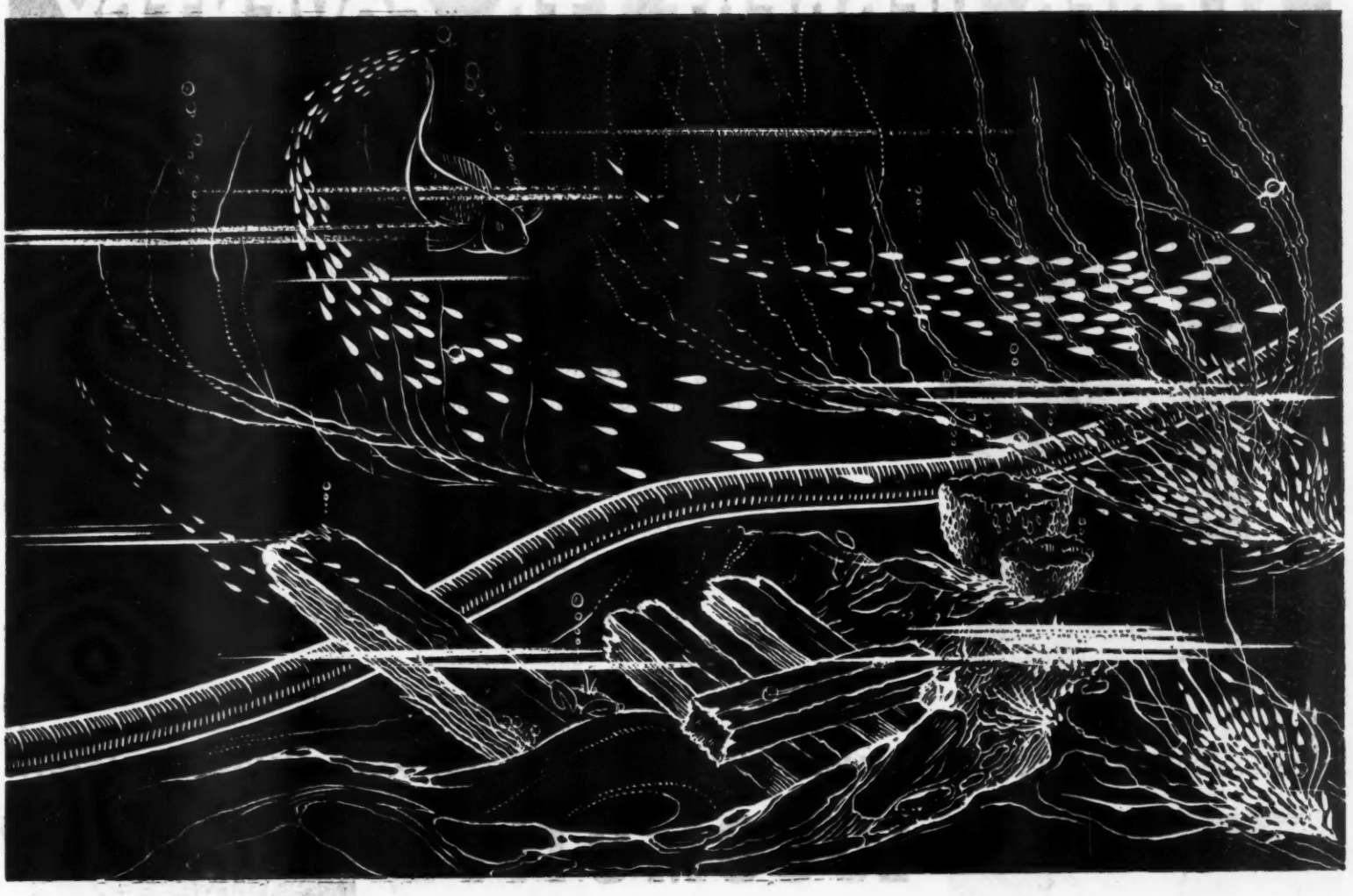
is illustrated in standard form below which develops 32 H.P. at 2,000 R.P.M. It is of compact design and possesses reliability and smoothness to a degree exceptional in a diesel. For marine propulsion, for cruisers, work-boats or auxiliary uses, this model is also available with reverse and 3 to 1 reducing gear and electrical starting.



GODIVA
PETROL & DIESEL ENGINES

Made by **COVENTRY CLIMAX ENGINES LIMITED**

H.P.



CABLE ARMOURING
calls for 'STRIBAR' STEEL STRIP

'Stribar' Hot Rolled Steel Strip is supplied in mill coils or lengths for cold rolling, stamping, pressing and deep drawing, cable armouring, flexible, welding and close-joint tubing, baling and barrel hoops, etc. Sizes range from 1 in. x (.030" to .190") to 9 in. x (.080" to .190") or slit to narrower widths.

THE UNITED STEEL COMPANIES LTD

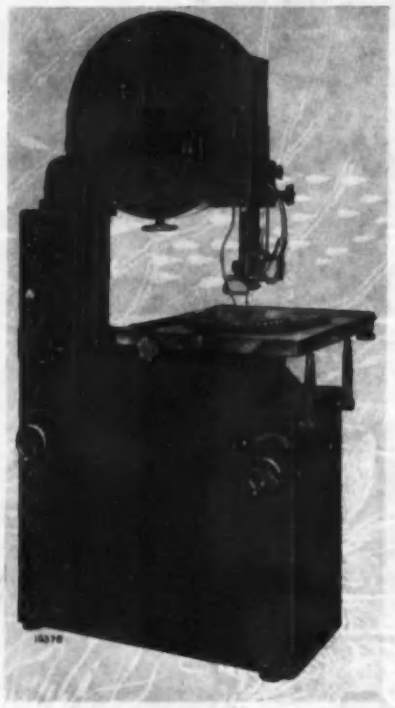
UNITED STRIP & BAR MILLS • THE ICKLES • SHEFFIELD

Branch of The United Steel Companies Limited

Telephones : Sheffield 41011; Rotherham 1090 Telegrams : "Stribar," Sheffield

BRS.53

ALFRED HERBERT LTD. COVENTRY



A VERSATILE MACHINE

The Tannewitz No. 24M Di-Sawing and Filing Machine will effect large savings in the manufacture of dies, tools, jigs, fixtures and similar work previously done on the lathe, shaper or milling machine.

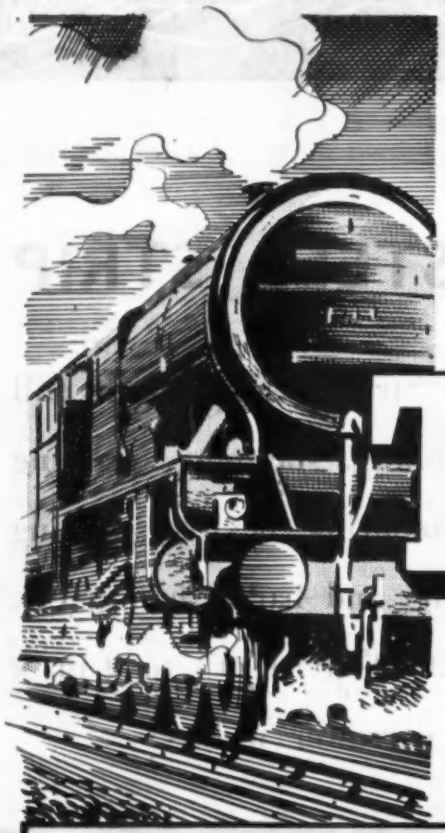
Easily adapted to filing or polishing operations. Speeds ranging from 60 to 1,000 ft. per min. are available. Drive is by standard ½ h.p. two-speed motor and twin variable speed pulleys ; a ¾ h.p. motor can be supplied, if desired.

Max. height under saw guide ...	11 in.
Size of table	24½ in. by 28½ in.
Height of table	43 in.

IMMEDIATE DELIVERY

Offered subject to prior sale.

Catalogue sent on request.



LOCOMOTIVE, MARINE AND CONDENSER TUBES

IN BRASS, COPPER, CUPRO-NICKEL, ALUMINIUM BRASS, ETC

B.N.F. Patent No. 308647 (1929)

and other alloys to specification.

TELEPHONE EAST 1221 PRIVATE BRANCH EXCHANGE

TELEGRAMS 'BOOTH BIRMINGHAM'

JAMES BOOTH & COMPANY (1915) LIMITED.

ARGYLE STREET WORKS,

BIRMINGHAM, 7.

CODES

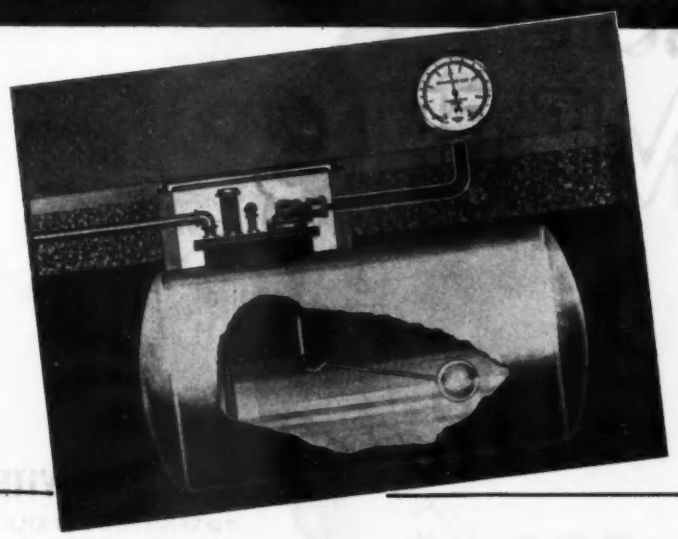
ABC 5th & 6th ED.

LIEBERS 5 LETTER

BENTLEYS SECOND PHRASE

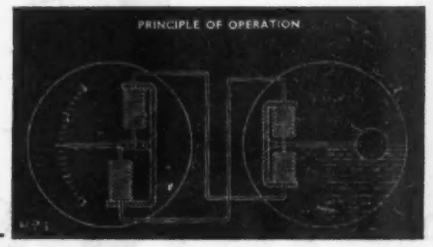
WESTERN UNION

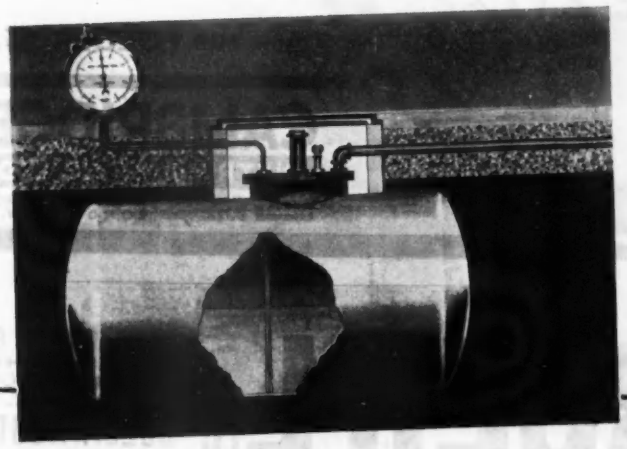
ACCURATE REGISTERING OF TANK CONTENTS



● **LIQUIDOMETER**— (Patent No. 482035).

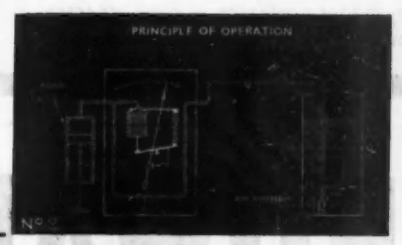
The Liquidometer Hydraulic Gauge indicates exactly and continuously the contents of near or distant tanks. Employing the principle of a balanced hydraulic circuit (See Figure 1) accurate readings are obtained without batteries, compressed air or manual operation. The accuracy of the gauge is entirely unaffected by temperature variations.





● **LEVELOMETER**— (Patent No. 495586).

The Levelometer Gauge works on the hydrostatic principle, measuring the head of liquid in the tank. It is of the remote reading type, recording directly on a dial and the indicator may be placed at any reasonable distance from the tank.



● **DIRECT READING**— (Patent No. 343909).

This gauge is designed for mounting directly on the top or side of the tank. The Direct Reading Gauge indicates tank contents by means of a float arm directly connected to the indicator.

For tanks under pressure or containing noxious liquids, Liquidometer or Direct Reading Gauges should be used.

The Levelometer Gauge measures contents by weight and is unaffected by changes in volume due to temperature conditions.

We shall be happy to discuss the installation of any of the above Contents Gauges to suit your own particular needs. Illustrated brochure gladly sent on request.

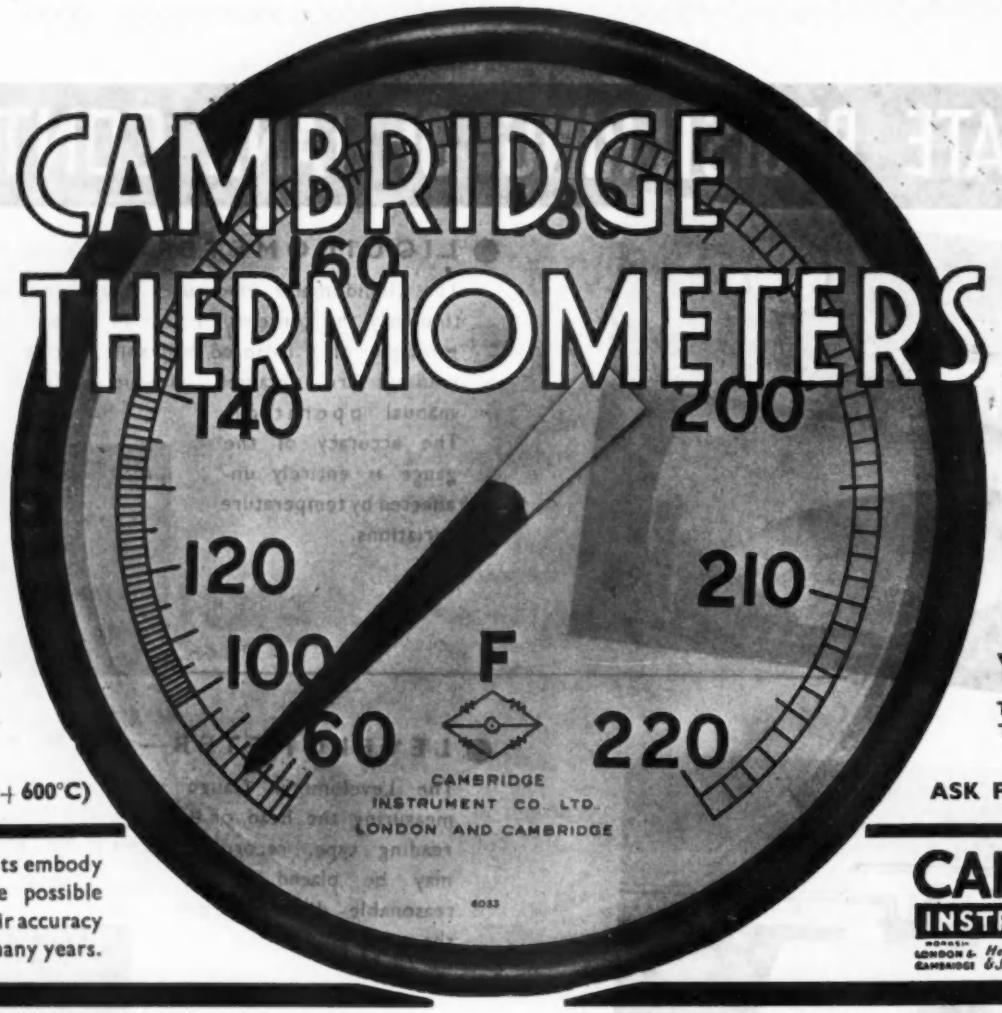
Simmonds

INDUSTRIAL CONTENTS GAUGES

SIMMONDS AEROCESSORIES LTD
GREAT WEST ROAD, LONDON.

Langley

CAMBRIDGE THERMOMETERS



DIALS 4IN., 6IN., 8IN., OR 13IN. DIAM.

FOR TEMPERATURES
-40°F. to + 1100°F (-40°C to + 600°C)

THESE robust instruments embody improvements made possible by modern research. Their accuracy may be relied upon over many years.

YOU ARE INVITED
TO SEND FOR DETAILS OF THESE INSTRUMENTS—

ASK FOR **FOLDER 65.G**

CAMBRIDGE
INSTRUMENT CO LTD
LONDON & CAMBRIDGE — Head Office & Showrooms — 13 GROSVENOR PLACE LONDON, S.W.1

EDWARD MERCER LTD.

MANUFACTURERS OF
BLACK & BRIGHT
BOLTS, NUTS, STUDS
SCREWS, ETC.
HOLLINWOOD,
LANCS.

516

"STAYBRITE"

FIRTH-VICKERS STAINLESS STEELS LTD., SHEFFIELD 9.

SEE ILLUSTRATED ADVERTISEMENT ON PAGE 22, DEC. 20.

Hadfields manufacture

STEEL CASTINGS

ranging from a few lbs. to 30 tons in weight.

Castings in Hadfield's Best Toughened Cast Steel, Hadfield's Patent "Era" Manganese Steel, and Special Steels for special purposes.

FORGINGS · ROLLED PRODUCTS

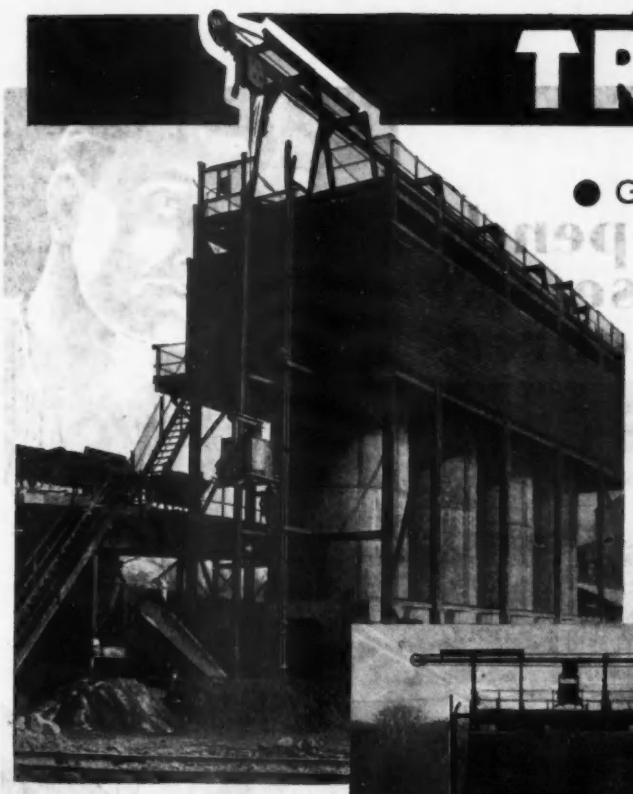
HADFIELDS LTD.

EAST HECLA & HECLA WORKS · SHEFFIELD · ENGLAND.

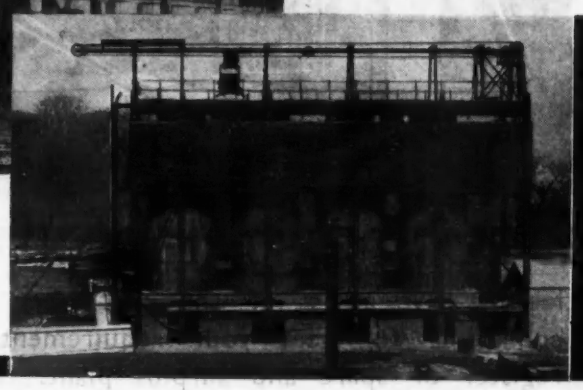
CROSSHEAD CYLINDER OF HADFIELD'S BEST TOUGHENED CAST STEEL FOR A LARGE EXTRUSION PRESS.

WEIGHT 15 TONS

TRANSPORTER HOISTS



- Giving vertical and horizontal motion of the skip, using only one motor and winch.
- Material elevated and discharged direct into any one of a line of hoppers, kilns, etc.
- Double handling and consequent wear and tear eliminated.
- Hoists can be FULLY or SEMI-AUTOMATIC and are BALANCED to save power.



The illustrations show a Hoist for charging Kilns.

STRACHAN AND HENSHAW LTD
WHITEHALL IRON WORKS
WHITEHALL
BRISTOL 5

GOODALL, CLAYTON & Co LTD LEEDS

ELEVATING & CONVEYING MACHINERY, ROOFS, BUNKERS, COLLIERY SCREENING PLANTS
PICKING BELTS, PIT HEAD GEARS, HEAPSTEADS, GAS RETORT INSTALLATIONS.

Uniform Hardening and Accurate Results . . .

in the heat treatment of steel, are always assured with HEENAN PATENT OIL COOLERS. Furthermore, they extract the heat from the oil at the same rate as it is received from the steel—thus allowing work to be continued for unlimited periods.

Read these advantages:—

- ***Heenan Coolers are affected less by dirty or scaly oil, than other forms of cooler.***
- ***No cold water is employed for cooling, thus eliminating trouble through water leaks.***
- ***They can be installed either inside or out of doors.***
- ***Risk of fire is greatly reduced.***

Send for descriptive literature to:—

HEENAN & FROUDE LTD
ENGINEERS · WORCESTER · ENGLAND

YOUR CONCERN!

With commendable regularity you probably read "ENGINEERING" every week and have come to look forward to the way it so faithfully deals with that branch of the engineering industry which directly concerns you : but, have you ever considered that what interests you is also the concern of your executives and representatives ?

Why not provide a sufficient number of copies of "ENGINEERING" every week for these members of your organization ?

The subscription rate is set out on Editorial Page 511, and you will be greatly surprised that

IT COSTS SO LITTLE!

IF YOU NEED PLANT FOR ARMAMENT PRODUCTION . .

let us have a list of the machinery you want and we will endeavour to meet your requirements from our up-to-date register of spare and surplus plant. We are also constantly placing engineers in touch with others who have suitable plant for disposal.

IF YOU HAVE PLANT FOR DISPOSAL . . .

send us complete specifications and we will either buy on our own behalf for cash, contact on your behalf with possible buyers or arrange showroom facilities in Coventry.

We offer our Services to you on a normal commission basis.

MODERN MACHINE TOOLS LTD.

PHONE 2132-5. BUTTS WORKS, COVENTRY GRAMS : MODERN PHONE COVENTRY.

LONDON DEPOT : CORNER GORST ROAD, PARK ROYAL ROAD, NORTH ACTON, N.W.10 PHONE : WILLESDEN 5688-9.

EXPANSION BOLTS

Interlocking KEYSTONE EXPANSION SHIELDS — *Double*
For Use With Machine Bolts

Hot Galvanized by the Diamond Process

Illustrated Lists and Particulars on application to the
SOLE AGENTS—

H. LUKE, LTD.,
12 & 14, Brazennose Street, Manchester, Eng. 8908

PIPE UNIONS
WHICH CANNOT FAIL IN SERVICE
ON COMPRESSED AIR, STEAM, OR WATER LINES.

Socket Unions in Malleable Iron, with ground ball joints, having brass seating, ensure the quickest, best and cheapest form of joint, on all services.
There is a great distinction between a JEFFERSON and any other union. The outstanding feature is the position of the brass seat. This is inserted in a recess, away from the pipe contents, and cannot become loose.
Spherically ground faces make a perfect joint, even with pipes out of line, on pressures up to 300lbs.
Hexagon ends give good grip for spanner, and frequent disconnecting does not affect tightness.
For medium pressures up to 200lbs. OXFORD Unions have the same features, but are lighter.

DISTRIBUTORS :—

BRITISH STEAM SPECIALTIES LTD.

FOR PIPE FITTINGS AND VALVES OF ALL TYPES, FOR GAS, STEAM OR WATER SERVICE

BEDFORD STREET, LEICESTER

Town Drilling Machines are outstanding for their greater ease of operation, time-saving manipulation, quicker and better drilling and low drilling costs.

TOWN
DRILLING MACHINES

FREDK. TOWN AND SONS
HALIFAX, ENGLAND

Longleys

THE "FLUXITE QUINS" AT WORK

"Do I look smart?" cooed OO.
Said EH "Indeed you do
Just trim and neat
And you're all complete
With your tin of FLUXITE too."

For all SOLDERING work—you need FLUXITE—the paste flux—with which even dirty metals are soldered and "tinned." For the jointing of lead—without solder; and the "running" of white metal bearings—without "tinning" the bearing. It is suitable for ALL METALS—excepting ALUMINIUM—and can be used with safety on ELECTRICAL and other sensitive apparatus.

With Fluxite, joints can be "wiped" successfully that are *impossible by any other method.*

Used for 30 years in Government Works. OF ALL IRONMONGERS—IN TINS—4d., 8d., 1/4 and 2/8. Ask to see the FLUXITE SMALL SPACE SOLDERING SET—compact but substantial—complete with full instructions, 7/6.

Write for Leaflets on CASE HARDENING STEEL and TEMPERING TOOLS with Fluxite, also on "WIPED" JOINTS.

The FLUXITE GUN puts FLUXITE where you want it by a simple pressure. Price 1/6d., or filled 2/6d.

FLUXITE LTD. (Dept. ENG.)
Bermondsey Street, S.E.1.

ALL MECHANICS *WILL* HAVE

FLUXITE

IT SIMPLIFIES *ALL* SOLDERING

SCRIVEN
FOR
MACHINE TOOLS
CROSTHWAITE FURNACES & SCRIVEN MACHINE TOOLS LTD.
York Street Ironworks, Leeds, 9.

THE
NEWBURY DIESEL Co. LTD
NEWBURY—ENGLAND
MARINE & INDUSTRIAL
DIESEL ENGINES UP TO 800 H.P.

RIGID FIXING WITHOUT DRILLING

LINDAPTER

HENRY LINDSAY LTD, BRADFORD

ELECTROMAGNETS LTD.
- for -
LIFTING MAGNETS
CLUTCHES, CHUCKS &
MAGNETIC SEPARATORS
for all purposes

Grams: Boxmag, Birm'ham | 48, HIGH ST., ERDINGTON, BIRMINGHAM, ENG^D. | Phone: Erdington 1908

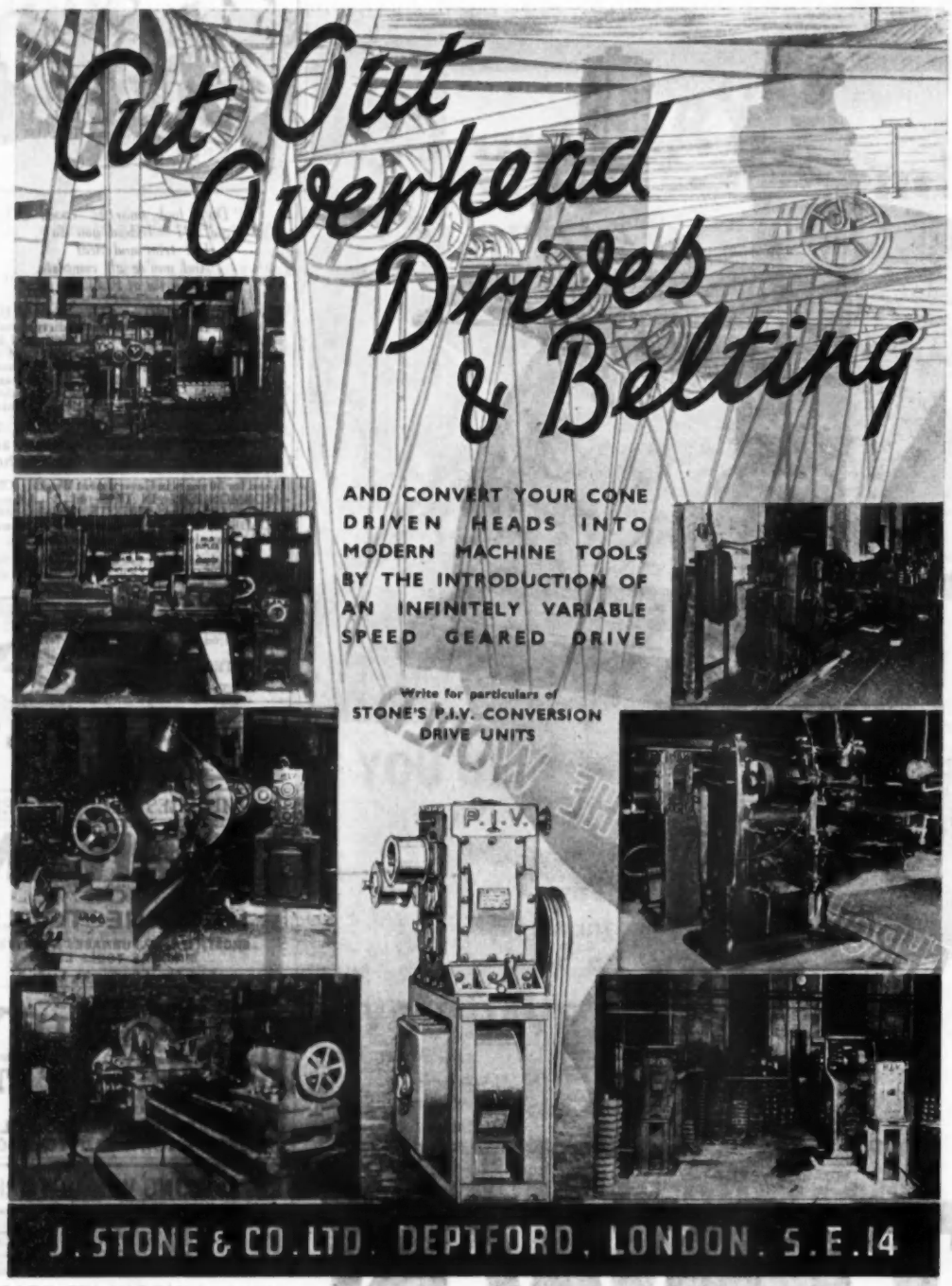
THE CUNARD WHITE STAR QUADRUPLE-SCREW LINER

"QUEEN MARY"

In Imperial Quarto 78pp. with 5 large folding Drawings and 179 Illustrations.

Price 6/- net. Parcel Post in United Kingdom 6/6 Book Post (abroad) 6/8

Temporary Offices of "ENGINEERING" 18-20, Compton Road, Hayes, Middlesex.


Cut Out Overhead Drives & Belting
AND CONVERT YOUR CONE DRIVEN HEADS INTO MODERN MACHINE TOOLS BY THE INTRODUCTION OF AN INFINITELY VARIABLE SPEED GEARED DRIVE
Write for particulars of
STONE'S P.I.V. CONVERSION DRIVE UNITS
P.I.V.
J. STONE & CO. LTD. DEPTFORD, LONDON. S.E.14

ENGINEERING DIRECTORY

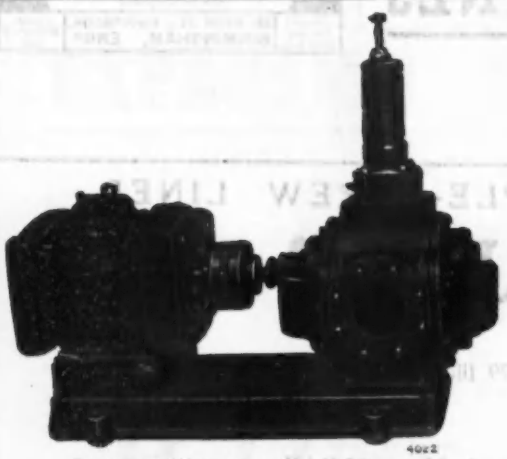
The current edition will be sent gratis on application to the Manager.

It is compiled from current advertisers in ENGINEERING and also contains the Telegraphic Addresses, Key to same, Telegraph Codes, Telephone Numbers and List of Trade Names used by Advertisers.

There is also a Glossary of Equivalents in German, French, Spanish and Italian.

ENGINEERING

18-20, COMPTON ROAD,
HAYES, MIDDLESEX



Direct coupled Motor Driven Horizontal Pump.

HAMWORTHY

"ROTAPAX" (PATENT) PUMPS

AXIAL FLOW, STEADY DELIVERY, SILENCE, and NO VIBRATION.

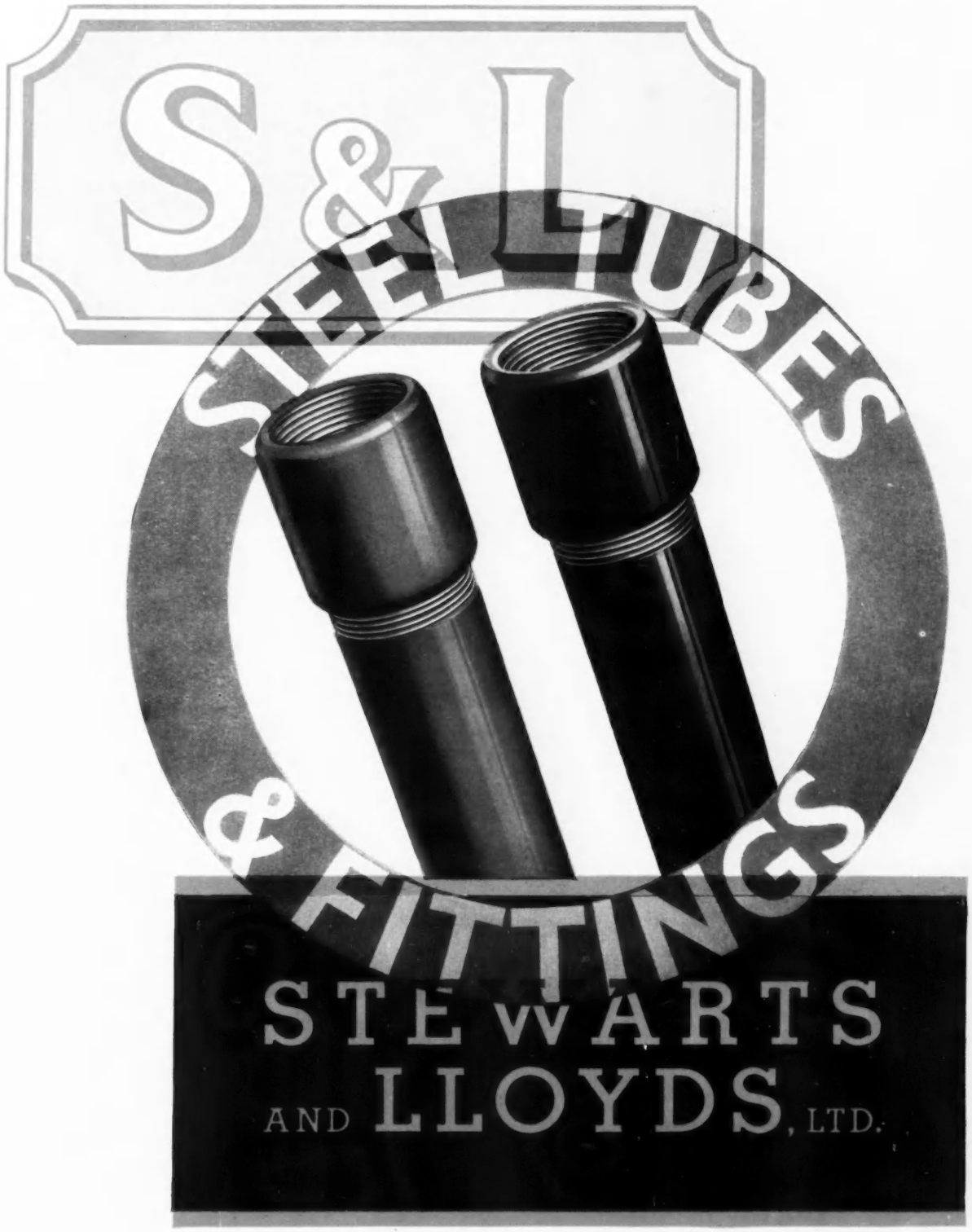
SEND YOUR ENQUIRIES TO:

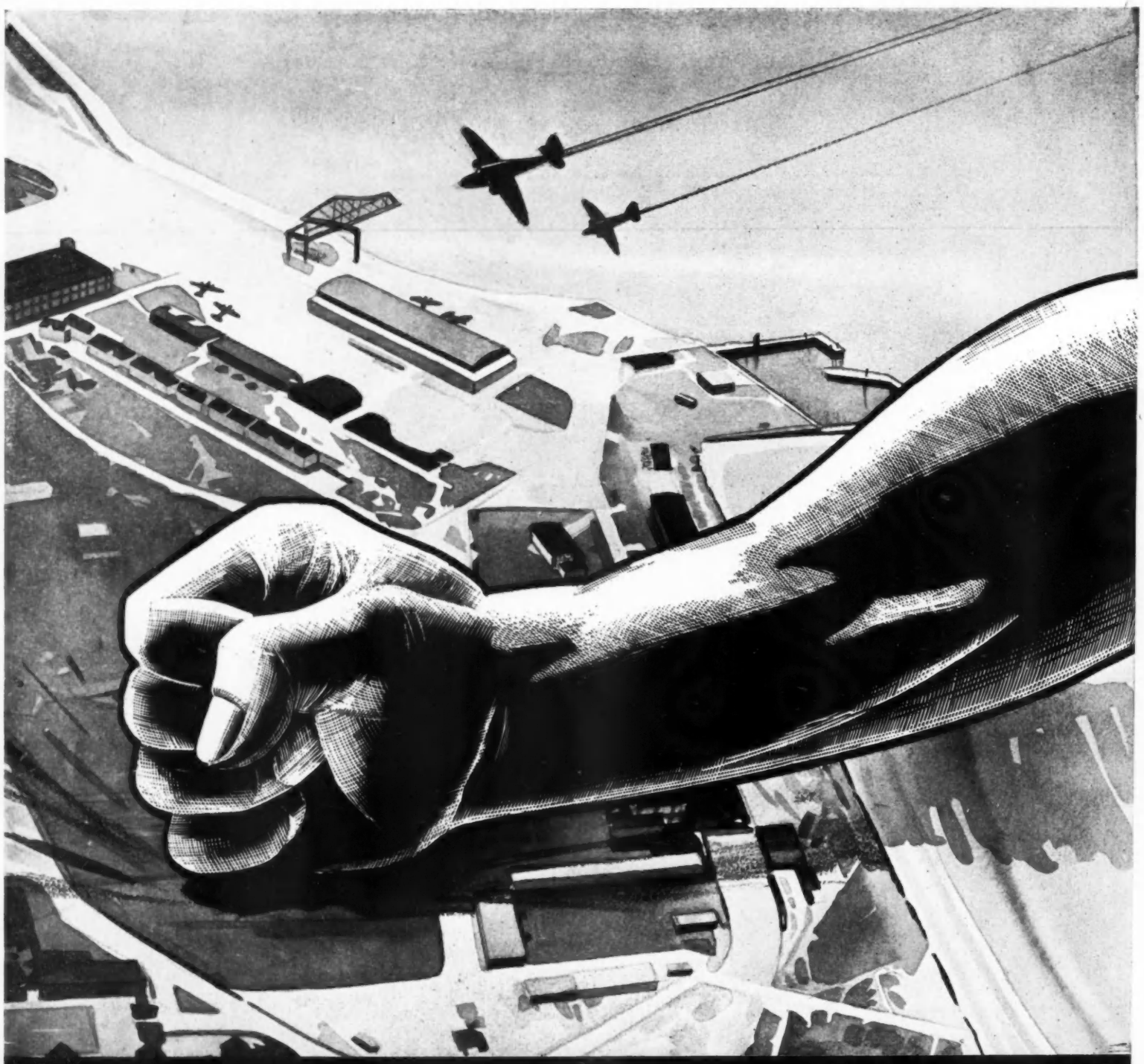
THE HAMWORTHY ENG'G. CO. LTD.

POOLE, DORSET—*'Phone: Poole 735*

and (London Office) 30 LYNWOOD DRIVE, WORCESTER PARK, SURREY.

'Phone: Derwent 4120.


S & L
STEEL TUBES
& FITTINGS
STEWARTS
AND LLOYDS, LTD.



SCIENTIFIC STRIKING

Wherever the R.A.F. strike, be it Sylt, Wilhelmshaven or Heligoland, the products of scientific striking, Firth-Derihon Alloy Steel Drop Stampings, go with them in the vitals of the world's finest aero engines and airframes.

FIRTH-DERIHON

STAMPINGS LTD

CARBROOK SHEFFIELD

OFTEN

we can

squeeze 'em in

TIMKEN tapered roller bearings will stand up to loads—radial, thrust or both combined—that other bearings cannot take.

There are thousands of bearings in use to-day which are being shamefully overloaded in an endeavour to boost things up under war conditions.

We are being asked to overcome the trouble by squeezing Timken bearings into the space available, and this we are often able to do with great success. But, to avoid swapping bearings in mid-stream, do please design in the first place with an ample reserve of load capacity.

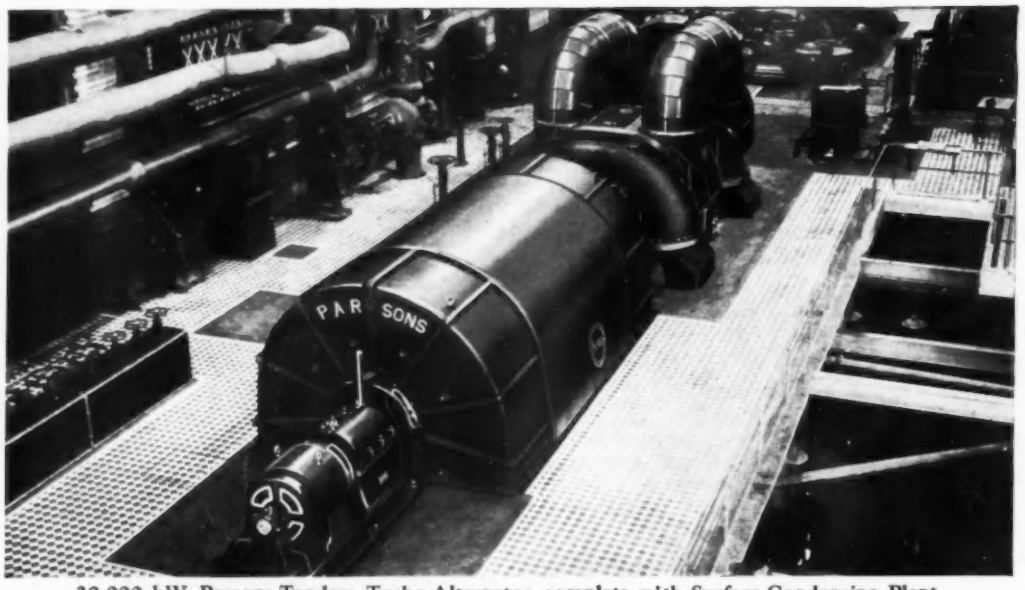
BRITISH TIMKEN LTD., CHESTON ROAD, ASTON, BIRMINGHAM, 7

Telephone: East 1321 (6 lines). Telegrams: Britimken, Birmingham. Registered Trade Mark: Timken.

ASSOCIATED COMPANY: FISCHER BEARINGS CO., LTD., UPPER VILLIERS STREET, WOLVERHAMPTON.

TIMKEN

TAPERED ROLLER BEARINGS



30,000 kW. Parsons Tandem Turbo-Alternator, complete with Surface Condensing Plant, installed in a Power Station in Great Britain. The Alternator generates direct at 30,000/36,000 volts.

C. A. PARSONS & Co LTD

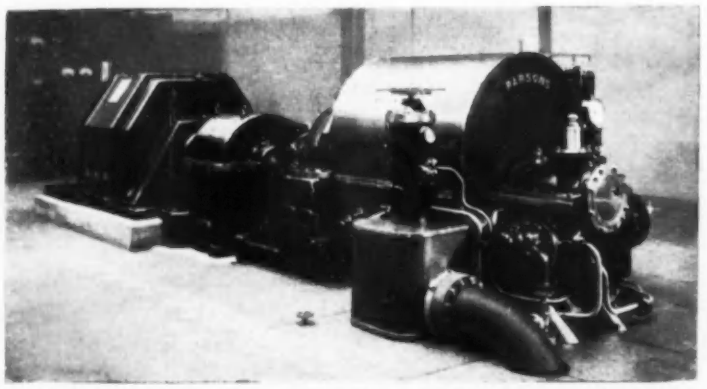
HEATON WORKS, NEWCASTLE - ON - TYNE

STANDARD PRODUCTS:

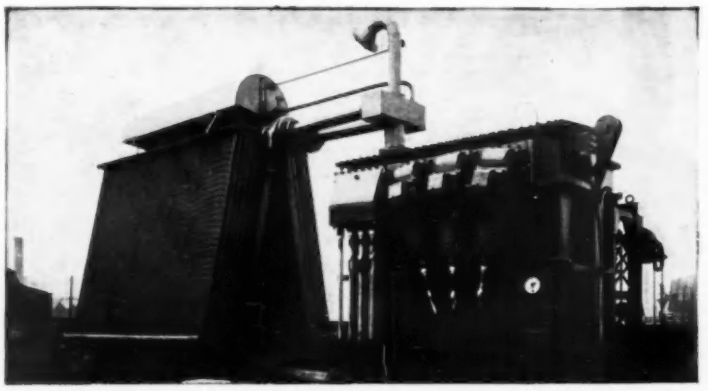
STEAM TURBINES - { High Pressure: Low Pressure / Mixed Pressure: Back Pressure / Reducing Type and Pass Out

ALTERNATORS - { Turbo Type and Open Type / Direct Generation at high voltages.

ELECTRICAL TRANSFORMERS, D.C. GENERATORS, TURBO - COMPRESSORS, TURBO - BLOWERS, SURFACE CONDENSING PLANT, PUMPS, SPEED REDUCING GEAR, TURBINE BLADING, FABRICATED STEEL STRUCTURES, WATER GAUGE PROJECTORS, SEARCHLIGHT REFLECTORS, METAL AND GLASS REFLECTORS FOR INDUSTRIAL PURPOSES, ASTRONOMICAL AND OBSERVATORY EQUIPMENT, Etc.



1,500 kW. Parsons Pass-out Geared Turbo-Alternator, complete with Surface Condensing Plant, installed in a British Paper Mill.



15,000 kVA. Transformer, supplied to a British Municipal Council.

14967-13631-12805.

LONDON OFFICE 56 VICTORIA ST., S.W.1.

SIR WILLIAM ARROL & Co. LTD., GLASGOW

BRIDGEBUILDERS.

REGISTERED OFFICE: 85 DUNN STREET, BRIDGETON, GLASGOW.

Telephone: Bridgeton 2131 Telegrams: "Tay, Glasgow"

Reprinted from the leaflet issued by the Ministry of Health and the Department of Health for Scotland

FIRST AID IN BRIEF.

AFTER AN AIR ATTACK, First Aid Parties will reach the wounded within a few minutes. Even such a short time counts. The man or woman on the spot can save lives by immediate and proper action.

Everyone in these days of danger should carry several clean handkerchiefs or small towels. These can be used as bandages, and their inner laundered surfaces are quite suitable for application to open wounds as a first dressing.

Unless a patient is in a highly dangerous place you should treat him where he lies. To lift or drag the wounded can do series damage. Your general rule is that the moving and transport should be left to trained parties.

The first and most important duty of the civilian helper who first reaches a casualty is to stop bleeding.
The application of pressure to a bleeding wound is the correct thing to do in all cases.

TO STOP BLEEDING.
Press on the bleeding point with fingers or hands. As soon as possible apply a clean thick pad of folded handkerchief or towel. Use an inner surface of your handkerchiefs or towels. Keep up the pressure through this pad. Bandage the pad firmly in position over the wound. Be sure that the dressing is applied firmly enough to control the loss of blood. If there is still oozing of blood past or through the pad renew pressure over the whole dressing.

BLEEDING FROM ARM OR LEG.
Press on the wound with fingers or hands. Apply a clean thick pad as soon as possible. Keep up pressure through the pad. Bandage the pad firmly over the wound. If this fails, pass a bandage, tie, handkerchief, elastic or fabric belt, or similar article, round the limb as close to the wound as possible, at a point between the wound and the trunk. Knot the fabric so that the limb is loosely encircled. Pass a stick through the slack loop and twist till the tightening of the band round the limb stops the blood loss, taking care not to pinch the skin. Hold tight till the First Aid Party arrives. If you have to do this, make a note of the time when you tighten the loop and give it to the patient or attach it to the limb. It is very important that the hospital surgeon should know this.

BLEEDING FROM THE HEAD.
Press with fingers or hands on the bleeding parts. Apply a clean pad as soon as possible. Keep up pressure through the pad. Bandage the pad firmly in position.

BLEEDING FROM THE TRUNK.
These wounds are usually grave. Cover them with several layers of dressing. Keep up gently firm pressure over the pads.

SHOCK OR COLLAPSE.
All wounded are liable to collapse. Control bleeding at once. Keep the patient lying down. Loosen clothing at neck and waist, but do not expose the patient to chill. Prop the head comfortably. Wrap blankets or coats round the patient, not forgetting gently to slip some under him. Put hot bottles, if available, outside the blankets. Let him smoke if he will. Give him plenty to drink, warm drinks preferably; the best of all is warm very sweet tea. By your presence and helpfulness encourage him. Follow this routine even in apparently slight cases It will save lives.

WARNING.
DO NOT GIVE FLUID TO CASES OF WOUNDING OF BELLY. Patients who have injuries to the belly must not be given anything by the mouth; not even sips of water should be swallowed, but the mouth may be rinsed out.

SUFFOCATION.
Pressure of fallen debris may compress the chest and cause suffocation. To release a person so buried is a matter of the utmost urgency. Do not waste a second.

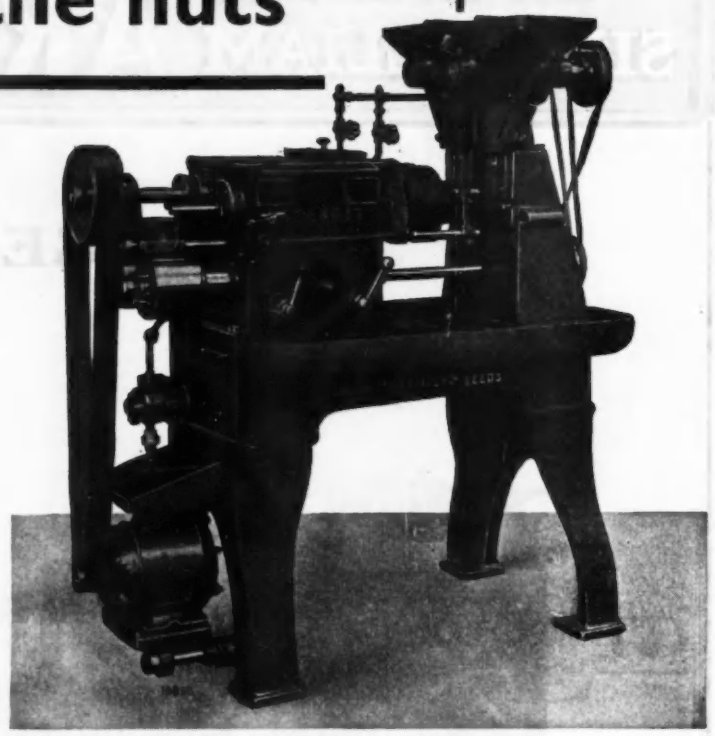
CLOTHES ON FIRE.
Take a rug or heavy coat. Wrap it round the victim. Prevent him running about. Lay him on the ground, using force if necessary. Smother the flames by pressure or beating through the rug.

TREATMENT OF BURNS.
Treat first for shock as described above. Treat the burn later. DO NOT APPLY OIL OF ANY KIND. The best thing to use, if available, is a substance such as one of the tannic acid jellies, which can be bought in tubes at any chemists. A very good substitute is a series of layers of dressing moistened with cold tea. If this is not at hand, cover the burn with dry clean dressings several layers thick.

IF YOU EXCEED THESE INSTRUCTIONS, YOU MAY DO GREAT HARM. LEAVE ALL OTHER TREATMENT TO TRAINED MEN.

Fill the hopper — remove the nuts

"GREENBAT" two-spindle Nut Tapping Machines are available in sizes to tap hexagon or square nuts from ⅛ in. to 1 in. The machines are entirely automatic in operation. The only attention required is to fill the hopper with nut blanks and to remove the tapped nuts. One operator can therefore handle five or six double spindle machines at full production. Single spindle machines are also available.

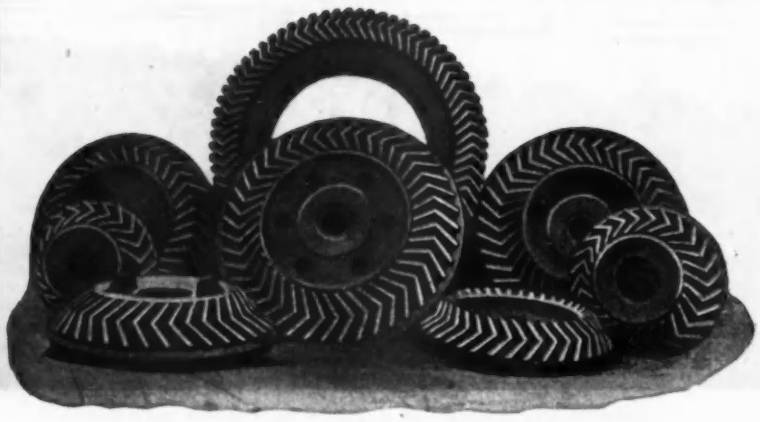


NUT TAPPING MACHINES

GREENBAT
GREENWOOD & BATLEY LTD.
ALBION WORKS LEEDS

N.T.S.A

STEEL CASTINGS



MACHINE MOULDED CAST STEEL HELICAL BEVEL GEARING.

by Open Hearth Acid Process, from 12 tons to a few pounds in weight.

TO PASS ADMIRALTY, LLOYD'S, BOARD OF TRADE OR BUREAU VERITAS TESTS.

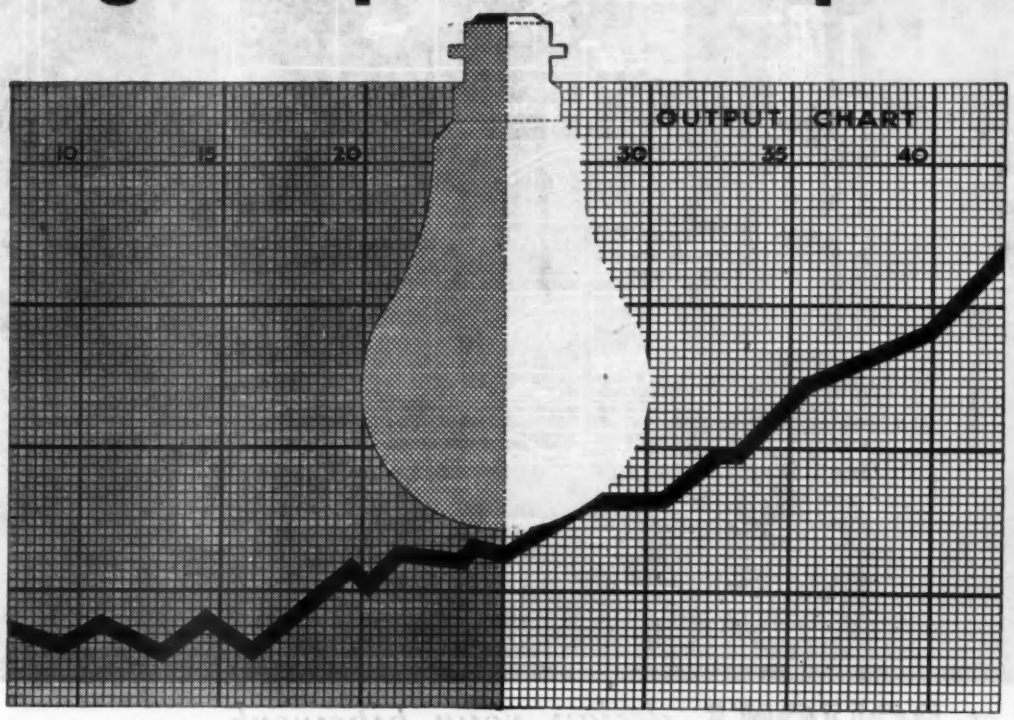
Castings for Railways, Shipbuilding Yards, Engine Works, Rolling Mills, Iron Works, Bridge Work, Hydraulic and Electrical Machinery, Mining, River Dredging Excavating Work.

SPECIALITIES:—
Tooth Wheels and Pinions used in connection with Cranes, Winches, Capstans, etc.
Cast Steel Anchor Heads.

W. SHAW & CO., Ltd., Wellington Foundry, **MIDDLESBROUGH.**

Telegrams—"WELLINGTON, MIDDLESBROUGH" ON ADMIRALTY AND WAR OFFICE LIST
London Office: 30, Grosvenor Gardens, S.W.1. Representative: Messrs. DAVIDSON & PEARSON.
Representative for Manchester and Birmingham Districts: T. W. F. DIXON, Clifflands, Lymm, Cheshire.
Glasgow Office: 4, West George Street, Glasgow. Representative: J. G. McOMIE
Agent for Durham and Northumberland: G. NELSON, Cathedral Buildings, Dean Street, Newcastle-on-Tyne. 775

Light up—for output!



Where increased output was once a matter of money it is now a matter of our very lives. Do not forget that good light everywhere keeps down accidents, avoids delays, makes fine work and inspection twice as fast. Fit Osram Lamps—sturdy, reliable—giving you the fullest possible value for every penny you spend on current.

Osram

A G.E.C. PRODUCT

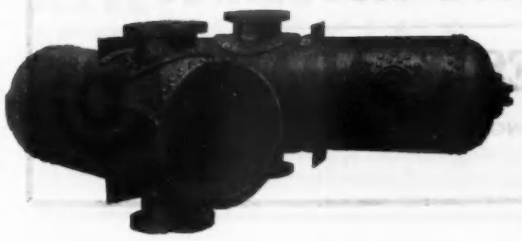
THE WONDERFUL LAMP

Advt. of The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2

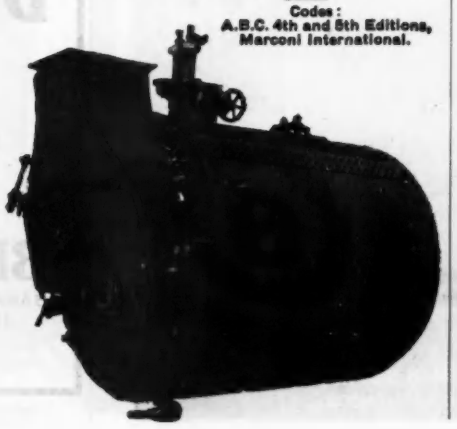
ABBOTT & CO. (Newark) LTD.,
NEWARK, Notts, England.

Makers of
STEAM BOILERS, AIR RECEIVERS,
VULCANIZERS, JACKETED PANS,
CIRCULAR and RECTANGULAR TANKS of RIVETED or WELDED CONSTRUCTION.
Flanged and Welded Work of every description.

Telegrams: "Abbott, Newark 34."
Telephone: Newark 34.
Codes: A.B.C. 4th and 5th Editions, Marconi International.



Contractors to the
Admiralty
War Office
India Office
Board of Customs
Crown Agents
Etc., Etc.



TERRY'S
Springs and Presswork

Springs and Presswork . . . Presswork and Springs. The astonishing range and variety of our work is a daily tribute to the way in which Terry's have met every demand for this class of work from every quarter of the globe for over 85 years.

HERBERT TERRY & SONS, LTD., REDDITCH.

London - - 27, Holborn Viaduct.
Birmingham: 213, Corporation St.
Manchester - - 279, Deansgate.

PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun and on occasions—be it admitted—of naughtiness.

Just now Peter's rather important for this is his first term at school, and he's grappling with the intricacies of "A B C" and "Twice-Two:" difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception.

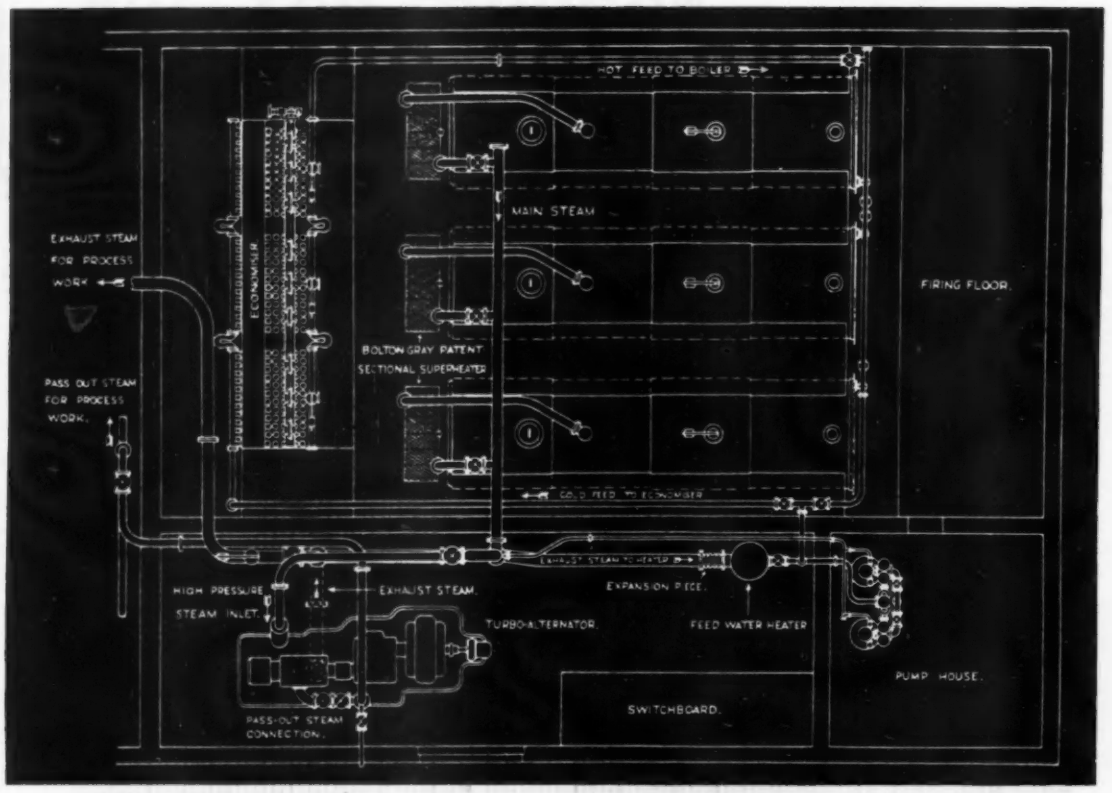
Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress. Would you like to know more about him? How, in spite of his "One Exception," he is being educated and, when older, technically trained and usefully employed.

There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

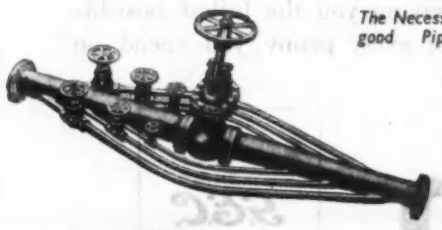
Will you help with a donation or annual subscription? Any sum, large or small, will be gratefully received. Here is a suggestion. Your eyesight is worth 3d. a year to you. Send Peter and his handicapped pals 3d. for every year you've had it. Now, please, in case it slips your memory Good idea?

The Chairman,

SCHOOL FOR THE BLIND
(Founded 1838)
SWISS COTTAGE, LONDON, N.W 3



Let **BOLTON'S** *design your pipework—*
for **EFFICIENCY**



The Necessity for good Pipework. The difference between the efficient plant, operating on a minimum coal and water consumption, and the plant which never seems able to deliver dry steam in sufficient quantity, or pressure, can generally be traced to the design of the pipework. Over 40 years of highly specialised experience is behind the advice and the products of Bolton's, coupled with unique facilities for the manufacture and erection of a complete plant or a single replacement bend.

Bolton's

BOLTON'S SUPERHEATER & PIPE WORKS LIMITED
STOCKPORT
Telephone Stockport 3604 (3 *lines*)

SUPERHEATERS : PIPE WORK : EXPANSION COMPENSATORS : PURIFIERS : STAINLESS STEEL WORK

d n510

BRECO ROPEWAYS

BRITISH ROPEWAY ENGINEERING Co LTD 14-18 HIGH HOLBORN LONDON W.C.1.
Telegrams "BOXHAULING-HOLB" LONDON.

DIE-PRESSINGS

HOT BRASS & BRONZE STAMPINGS.

CAPSTAN & MACHINED WORK FROM STAMPINGS OR BAR

BAKELITE MOULDINGS

BROOKES & ADAMS Ltd.

BARR STREET,
HOCKLEY, BIRMINGHAM,
ENGLAND.
Tel.—NOR 2903-4.

MAY WE ADVISE OR QUOTE YOU?
Tel. Add.—"Telsbs"

SHAW

TAKE IT THROUGH A STURDIGEAR

Pump, oil engine, turbine, marine and all other engineers requiring speed increasing or reducing units for building-up into complete sets can rely upon Shaw STURDIGEARS for duties involving overloads, uninterrupted running and trouble-free service.

STURDIGEARS are produced to the highest standards of accuracy; every tendency to deflection, vibration and resonance has been foreseen in design and eliminated, so that the units are very quiet-running.

For the sake of your own reputation, specify STURDIGEAR speed increasing or reducing units.

GEAR CUTTING.

We undertake the cutting of helical and spur gears on customers' own blanks. Send us your enquiries.

STURDIGEAR

FRANCIS SHAW & CO. LTD., CORBETT ST., MANCHESTER 11.

G.100

MACHINE CUT GEARS
SPUR. BEVEL. WORM.
SPIRAL. RACK.
COMPLETE GEARS
or
CUTTING YOUR BLANKS.

RODGERS BROS. LTD.,
LONDON GEAR WORKS
BLACKWELL STREET,
BRIXTON ROAD, S.W.9.
TELEPHONE: RELIANCE 2851 (2 lines).

ENGINEERS STORES
EVERYTHING IN STOCK

PACKINGS for every purpose
H.P. Jointings, Manhole and Mudhole Rings, Tools of every description, Steam Fittings, Valves, Tubing and Fittings, Asbestos, Graphite, Pipe Joint Compound, Pulleys, Shafting, Belting, Belt Syrup
QUALITY—SERVICE

ALEXANDER KENYON
& CO., LTD.
Victoria Bridge, Manchester.

Springs and Spring Washers
FOR ENGINEERING PURPOSES

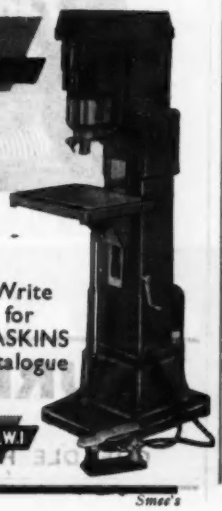
Manufactured by
JOHN TONKS
AND CO.,
Central Spring & Steel Works
Furnace Hill,
SHEFFIELD, 3.
TELEPHONE: 24679 SHEFFIELD. TELEGRAMS: TONKS, SHEFFIELD

CRAVEN
electric cranes
Craven Bros. Crane Division Ltd. Loughborough

RETORTS for OIL SHALE
FURNACES for ALL
PURPOSES PATENT RETORTS LTD.
Cab.: DASCOBIC, LONDON. 5, Victoria St., London S.W.1. Phone: Abbey 244

CENTRIFUGAL
PUMPS
and HIGH SPEED ENGINES
DRYSDALE & CO. LTD.,
YOKER, GLASGOW, W.4

MARBAIX
FOR UNUSUAL MACHINES
TAPPING!
AIR Control
It's Safer and Quicker with the HASKINS AIR CONTROLLED TAPPING MACHINE



Write for HASKINS Catalogue

GASTON E. MARBAIX LTD., HUMGLAS HOUSE, CARLISLE PLACE, LONDON, S.W.1

Smee's

BATTERY
SUNBEAM

COPPER and BRASS Sheets — Plates — Strip — Rods — Wire, etc.
PHOSPHOR BRONZE Tubes and Sheets.
CONDENSER TUBES in Brass, Cupro-Nickel and Aluminium-Brass ("Batalbra" Brand).
CONDENSER PLATES in Yellow Metal and Naval Brass.

THE BIRMINGHAM BATTERY & METAL CO. LTD.
Selly Oak . . . . . Birmingham 29

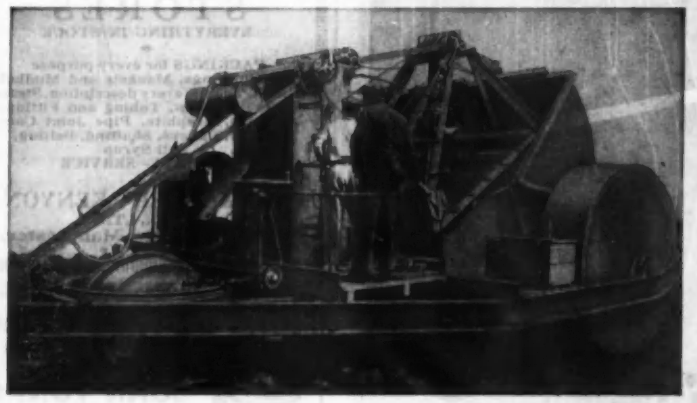
McLAREN
CABLE OPERATED SCOOPS

which will

WORK UNDER ALL WEATHER CONDITIONS
LOAD AND DISCHARGE ALL CLASSES OF EARTH
TRAVEL WITH LOAD UP 1 IN 3 GRADES
GIVE PERFECT CONSOLIDATION

MADE IN ROLLER OR WHEEL DESIGN

8-10 CUBIC YARDS CAPACITY



Also makers of Diesel Engines and Cable Ploughing Tackle

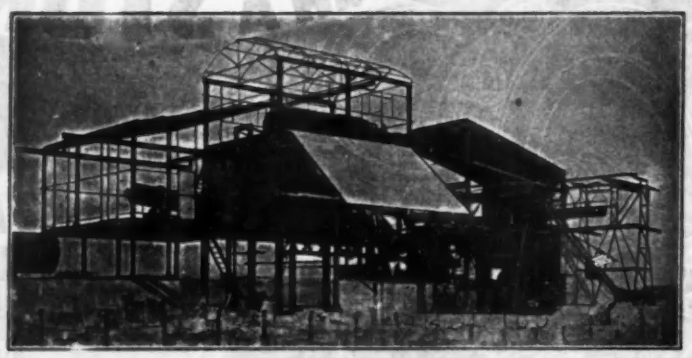
Write for full particulars to:—

J. & H. McLAREN LTD.

Midland Engine Works 810 **LEEDS, 10**

- STEEL - STRUCTURES

OF EVERY DESCRIPTION



DESIGNERS AND MANUFACTURERS OF ROOFS, BUILDINGS, WORKSHOPS, FACTORIES, BRIDGES, TANKS, FENCING, &c.

—The—

CLYDE STRUCTURAL IRON CO., LTD.,

CLYDESIDE IRON WORKS, Scotstoun, GLASGOW

7814

LONDON OFFICE: 1, Leadenhall Street, E.C.3.

Telegrams: "CORRUGATED, GLASGOW." Codes: A.B.C. (5th Edition) and LIEBER'S.

BROADY'S REDUCING VALVES

Any Pressure. Any Temperature

For Superheated or Saturated Steam, Gas, Air and Liquid

As fitted on H.M. Ships and by Leading Shipowners and Manufacturers

TYPE "S. B."

CATALOGUES ON REQUEST

WILLIAM BROADY & SON LTD ENGLISH ST HULL

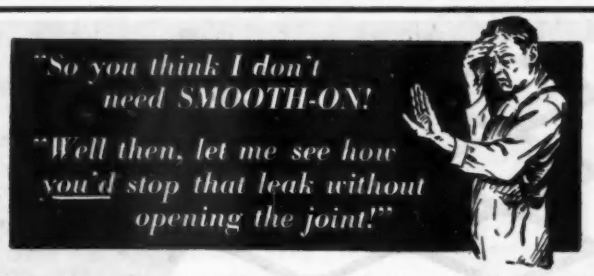
GEARS *and* GEAR UNITS

Also makers of Spiral and Straight Bevel Gear Generators and Worm Wheel Generators.

TURBINE GEARS LTD.

***(Subsidiary of* HENRY SIMON LTD.)**

CHEADLE HEATH - - - - STOCKPORT.



THIS man knows that Smooth-On No. 1 is simple to apply, makes dependable repairs, costs very little, and puts the defective part back into trouble-free service in a hurry.

Usually a leaky pipe joint or connection can be sealed with Smooth-On without disassembling, and in the case of a cracked boiler section, tank puncture or similar emergency, a quick, cheap and permanent Smooth-On repair makes a mere incident out of what might otherwise be a catastrophe.

Smooth-On holds in any metal, against gas, steam or water pressure, is not impaired by vibration or extreme temperature change, and restores perfect tightness at stripped or loosened screws, bolts and nuts.

To assist in determining correct application and getting good results, we have issued the SMOOTH-ON HANDBOOK, which explains all Smooth-On compositions and their uses, and contains simple instructions and working diagrams for stopping leakage and tightening loose parts under all sorts of conditions. This booklet should be consulted whenever the repair procedure is in doubt. Write for a free copy.

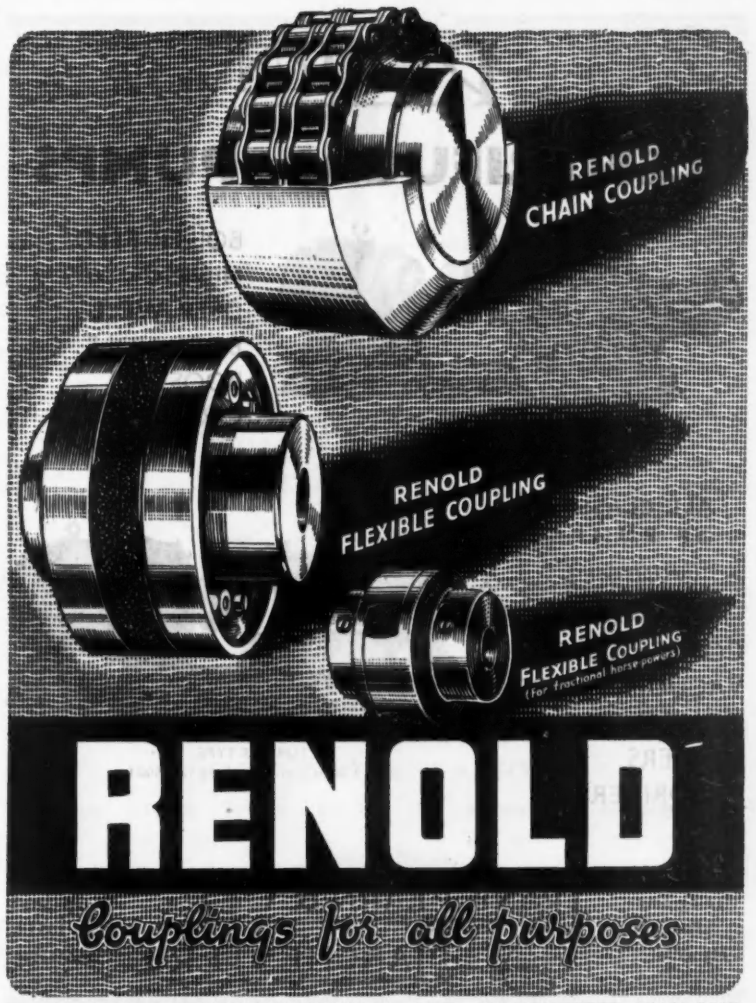
Write for this booklet.

Buy Smooth-On No. 1 in 1 or 5 lb. can or larger keg.

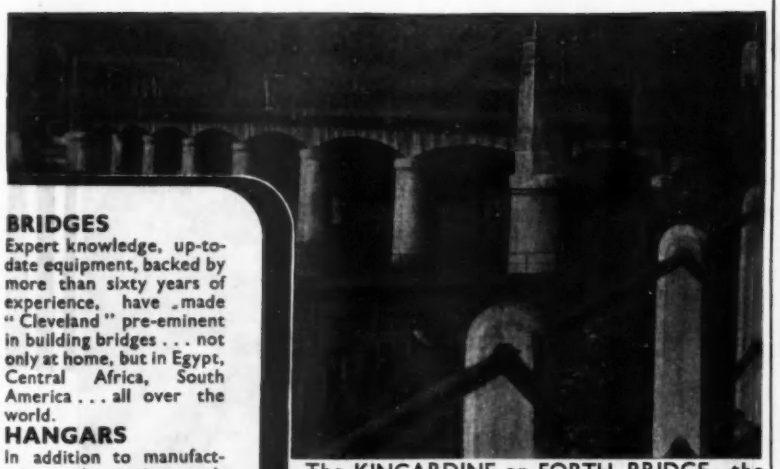
Distributed by Messrs. WALTER P. NOTCUTT LTD., Notcutt House, Southwark Bridge Road, London, S.E.1

Made by Smooth-On Mfg. Co., Jersey City, N.J., U.S.A.

Do it with SMOOTH-ON



THE RENOLD & COVENTRY CHAIN CO. LTD., MANCHESTER, ENGLAND



The KINCARDINE-on-FORTH BRIDGE—the largest swing span in Europe—is one of the many proofs of "Cleveland" engineering skill —both at home and abroad.

BRIDGES
Expert knowledge, up-to-date equipment, backed by more than sixty years of experience, have made "Cleveland" pre-eminent in building bridges . . . not only at home, but in Egypt, Central Africa, South America . . . all over the world.

HANGARS
In addition to manufacturing and erecting steelwork for Hangars "Cleveland" will quote for all necessary foundation and building work.

PIPE LINES
Contracts for the supply of riveted steel pipes have been completed at places as far apart as Wales and Calcutta.

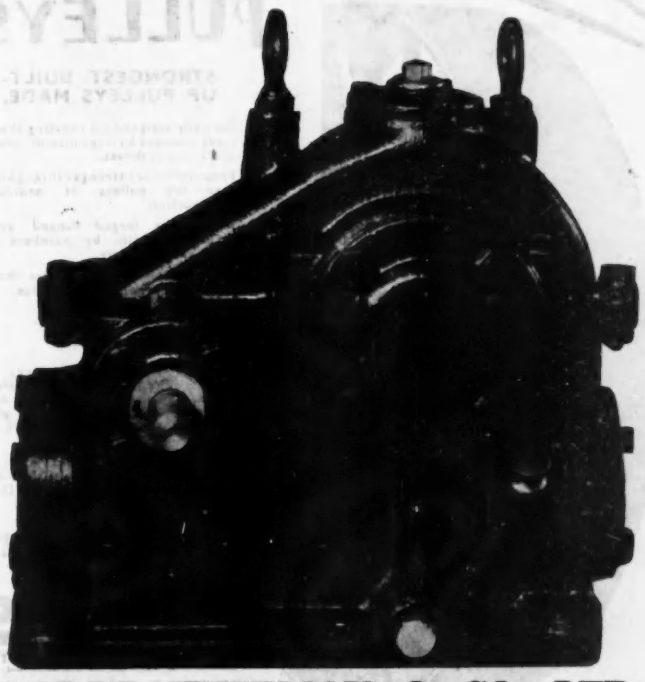
LANDING STAGES
Including construction of steel pontoons, making of floating roadways, laying of tracks for vehicles.

STRUCTURAL STEELWORK
"Cleveland" supply steelwork of all kinds and, in addition, contract for all building, and road-making in connection with the work. Types of contracts vary from Railway Stations and mooring masts to River Stations and Dock Gates.

built by CLEVELAND

THE CLEVELAND BRIDGE & ENGINEERING CO. LTD.
DARLINGTON · ENGLAND
Telephone :— Darlington 2710
Telegrams "Cleveland • Phone • Darlington"

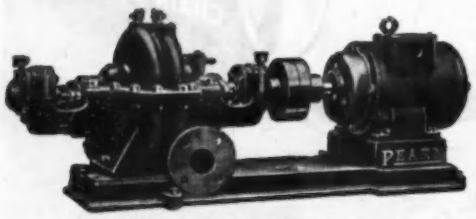
REDUCTION GEAR UNITS
FOR INDUSTRIAL PURPOSES
Helical or Straight Spur Wheels
in
Cast or Forged Carbon or Alloy Steels.
Standard or Special Designs.



ALFRED WISEMAN & CO. LTD.
Glover Street, BIRMINGHAM.
Telegrams: "Verus, Birmingham." 9465 Telephone: VIC. 2216-7.

PEARN

CENTRIFUGAL PUMPS



SPLIT CASING TYPE (SINGLE AND TWO-STAGE)
50 to 2,500 g.p.m. Heads up to 400 feet.

BOILER FEED
MINING
DEEP WELL
BORE HOLE
BOOSTER
CIRCULATING

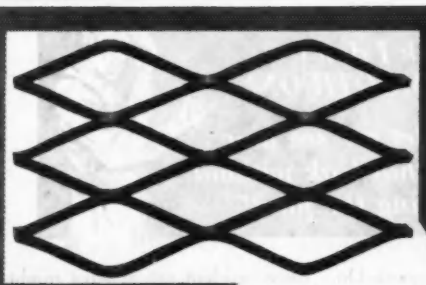
ALL CLASSES OF PUMPS
(Reciprocating and Centrifugal)
COMPRESSORS
VACUUM PUMPS
CONDENSERS
HEATERS
CALORIFIERS

TURBINE TYPE.
75 to 1,500 g.p.m. Heads up to 1,500 feet.

Telegrams: "Pumps," Manchester.

FRANK PEARN & Co. LTD.
MANCHESTER 12.

Telephone: East 1053/5 Manchester.



"Expamet" Expanded Steel is manufactured in twelve different sizes of mesh, each of which is made in several standard weights; it is used as a reinforcement for all forms of concrete, brickwork and plaster construction. It is used also for lift enclosures, openwork partitions and floor-ing, switchboard enclosures, lockers for clothes and tools, and for many other purposes.

"EXPAMET"
EXPANDED METAL

Designs and estimates will be submitted free of charge for the reinforcement for forms of concrete and fire-resistant con-struction. Illustrated technical booklets will be sent on request.

THE EXPANDED METAL CO. LTD.
Patentees and Manufacturers of Expanded Metal.
Engineers for all forms of Reinforced Concrete and Fire-resistant Construction.
"Dunedin," Underwood Road, Caterham, Surrey
Works: West Hartlepool. Established over 45 years.

Shock loads

"TITAN ARM" PULLEYS

STRONGEST BUILT-UP PULLEYS MADE.

Specially designed for resisting shock loads imposed by intermittent, heavy and arduous drives.

Proportions are stronger throughout than for pulleys of ordinary construction.

Arms have forged flanged ends secured to rim by numbers of independent rivets.

Made in all sizes to meet most strenuous conditions of service.

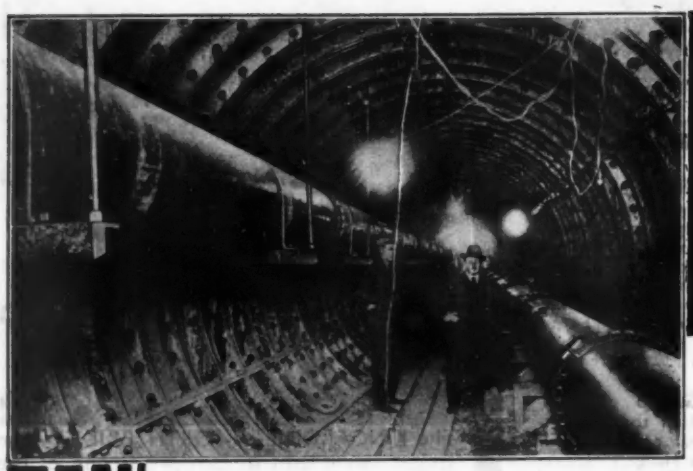
We make all types of W.I. Pulleys in all sizes up to 20 ft. dia. Any width of face, and give QUICKEST DELIVERY.

Standard construction Pulleys up to 60 in. dia. despatched SAME DAY AS ORDERED.

FOR QUICK DELIVERY Send all pulley inquiries to

CROFTS
(ENGINEERS) LTD
BRADFORD

LARGEST MAKERS OF PULLEYS & MILLGEARING APPLIANCES.



WELDED AND RIVETTED STEEL MAINS

We are specialists in the manufacture of all classes of Structural Steelwork, Tanks for oil, water, etc., Gasholders and Gasworks, Plant, Boilers, etc.

9636

CLAYTON, SON & Co. LD.
'Grams: "Gas Leeds." **LEEDS.** London Office: 2, Victoria Street, S.W.1

CONVERT TO BRAMMER V-LINK BELTING

Here is a belt of proved reliability that never slips, never stretches, never stops production. It is made up of detachable interchangeable links, and is ideally suited to power drives of either 40° or 28° angularity. Its patent construction ensures maximum life with a minimum of attention.

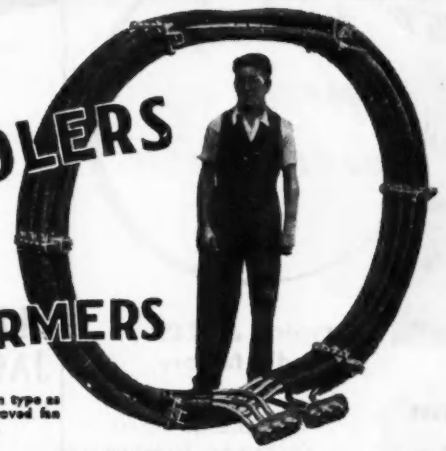
NON-SLIP
NON-STOP
NON-STRETCH

H. BRAMMER & CO. LTD.
KIRKSTALL RD. LEEDS

SPIRAL TUBE

High efficiency

OIL COOLERS for ELECTRIC TRANSFORMERS



Direct radiation type as shown or improved fan cooled pattern.

The SPIRAL TUBE & COMPONENTS Co. Ltd.
HONEYPOT LANE, STANMORE, MIDDX., & OSMASTON PARK ROAD, DERBY

PORTABLE HEAT FROM OIL

Wells' Heating Plants

Suitable for ENGINEERS, SHIPBUILDERS AND REPAIRERS, WATERWORKS CONTRACTORS, RAILWAY CARRIAGE AND WAGON WORKS, MUNICIPAL ROADS AND TRANSPORT DEPARTMENTS.

Wells' heating plants are made in eight different sizes and whatever the work, if portable heat is required there is a Wells' plant suitable for the job. There are small plants using as little as half a gallon of paraffin per hour to powerful plants giving a flame of 2,150 degrees Fahr, (and consuming 2½ gallons per hour). If portable heat is one of your problems—let Wells solve it for you.

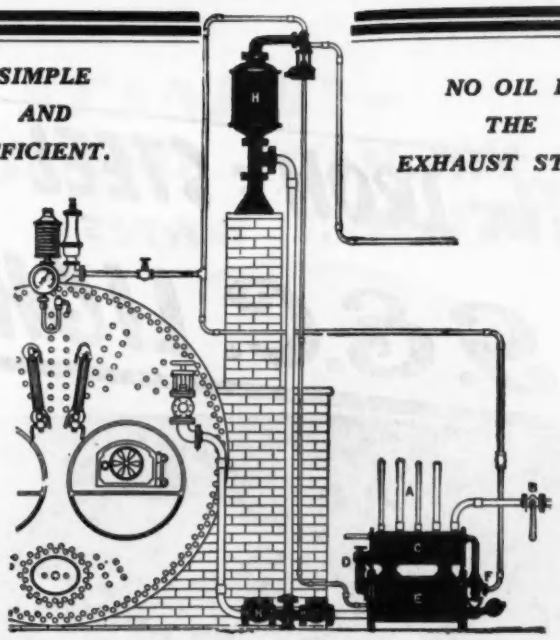
Write for complete list A.2.

A. C. WELLS & CO., LTD

CARNARVON ST., CHEETHAM, MANCHESTER, 3
'PHONE: Blackfriars 8044 'GRAMS: "Unbreakable, Manchester."

SIMPLE AND EFFICIENT.

NO OIL IN THE EXHAUST STEAM.



AUTO-THERMAL FEED

Specially designed for returning to the Boiler

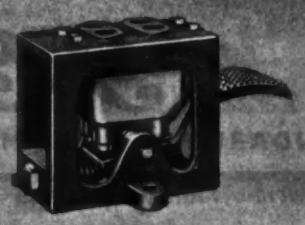
HOT CONDENSATION

from Steam Traps, giving the maximum economy.

Royles Limited
Trafford Park, Manchester 17

9178

'The Bridle for Air Horsepower'



Foot Controlled Ross Air Valve

ROSS AIR VALVES

Below is illustrated a Foot Controlled Ross Air Valve operating a hydro-pneumatic aircraft riveting machine.

Ross Air Valves employ the poppet principle, which means simplicity of design, delicacy of control and speed of operation—the speediest valve obtainable.

Positive sealing of valve seats is assured by the pressure exerted against underside of metal cup washers in which synthetic oil-resistant rubber is permanently vulcanised.

Air tight service over long periods of use reduces maintenance costs to a minimum.

Operated by Foot, Hand, or Solenoid to be used on Air Actuated Machinery.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LTD.
VICTORIA STATION HOUSE, LONDON, S.W.1, & DARLASTON, SOUTH STAFFS.

The IRON & STEEL industry uses G.E.C. LIGHTING

to help speed up production

A typical G.E.C. lighted factory

These Firms have increased production with the help of G.E.C. lighting—

Beeston Boiler Co. Ltd. . Cargo Fleet Iron Co. Ltd.
Dorman Long & Co. Ltd. · Leys Malleable Castings Ltd.
Richard Thomas & Co. Ltd. · Skinningrove Iron Co. Ltd.
South Durham Steel & Iron Co. Ltd., *etc.*, *etc.*

The G.E.C. manufactures a wide range of fittings and equipment for Industrial Illumination, and expert guidance on Factory Lighting is available from G.E.C. specialized Illuminating Engineers.

Consult the G.E.C.
FOR ANY STANDARD OF ILLUMINATION

Advt. of The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2

Electro-Mechanical
BRAKES
A.C. & D.C.

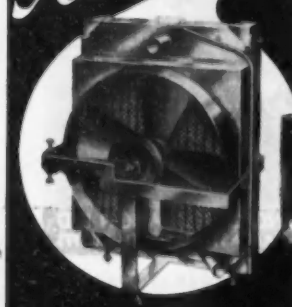
DESIGNED FOR HARD SERVICE SMOOTH AND POSITIVE IN ACTION. ASBESTOS FABRIC LINING TO SHOES. OPEN AND WATER-TIGHT PATTERNS.

ELLISTON, EVANS & JACKSON, LIMITED.
24, RAY STREET, FARRINGDON ROAD, LONDON, E.C.1.

McLAREN
LIGHT WEIGHT HIGH SPEED
DIESEL OIL ENGINES
FOR EVERY PURPOSE 620
J. & H. McLAREN, LTD., LEEDS, 10

For PUMPING & CIRCULATING
The Mopump
Patentees and Sole Manufacturers:
RHODES, BRYDON & YOUATT, Ltd. - Stockport, ENGLAND.
STANDS UNRIVALLED

Distinctive Features of
SERKOOL RADIATORS



VIBRATION PROOF.
Belt Adjusting Device can be operated without stopping the engine.
Felt Lining attached to the Cowl ensures proper Fan Suction and eliminates metallic vibration and noise.
Cooling Element removed by releasing two bolts.
Write for full particulars and descriptive leaflet.

H. O. SERCK LTD.
TELEPHONE COLLYHURST 1541/2 TELEGRAMS SERCKRAD MANCHESTER
LYON ST., OLDHAM RD., MANCHESTER 10

PARSONS

"SEEFLO"
CIRCULATION INDICATOR
(prov. pat.)

YOU CAN SEE THE WATER FLOWING

The Parsons Engineering Co., Ltd.,
Phone: 4662. Southampton. 'Grams: Parsengco.

GRAFTON

FOR

STEAM & ELECTRIC

CRANES

ESTABLISHED 1880

Telephone : Bedford RD 2490

Telegrams : "GRAFTON" BEDFORD

GRAFTON CRANES LTD.,
BEDFORD.

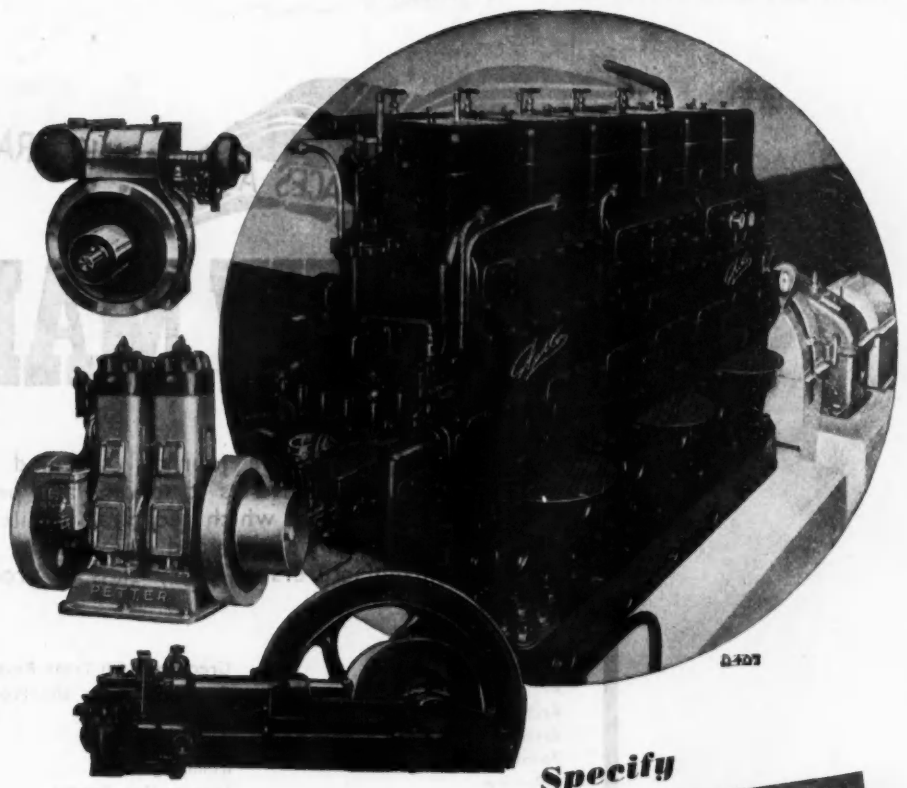
Wallwork
WORM AND SPUR GEAR DRIVES

The Motherwell Bridge & Engineering Co., Ltd.
Engineers & Contractors,
Bridges, Roofs, Piers, Tanks, Dock Gates, Hydraulic Pressed Flooring, etc.
Grams: "Bridge, Motherwell." MOTHERWELL, N.B. Tel.: Nos. 40 & 41.
London Office : 82, Victoria St., London, S.W.1
Grams: "Mobricolin, Sowest, London." Tel.: 4189 Victoria
See illustrated advt. last and next week.

MORRIS
BOILERS
Herbert Morris Ltd Loughborough

BRIQUETTE MACHINERY
FOR
Coal, Coke, Ores, etc.
Write : Herbert Alexander & Co., Ltd.,
Charmouth Street, Leeds.

For MAIN or STANDBY—
Reliable Electric POWER and LIGHTING



THE Petter Range of Oil Engines affords an extensive field of choice for all powers between 1½ and 375 B.H.P., vertical and horizontal types. Inherent features of design and high class workmanship ensure dependability under all conditions.

Write for particulars

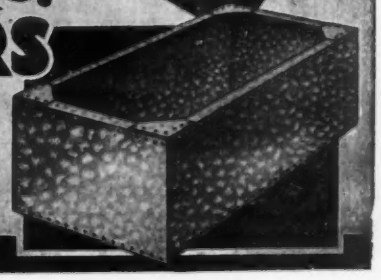
Specify
Petter
OIL ENGINES

PETTERS LTD., LOUGHBOROUGH, ENGLAND 4-107

JOSEPH ASH & SON LTD
TANK MAKERS.
GALVANIZERS

GENERAL IRON & STEEL PLATE WORK.
CONSTRUCTIONAL IRONWORK.
ELECTRIC AND ACETYLENE WELDING

REA STREET SOUTH, BIRMINGHAM. 5
TELEGRAPHIC ADDRESS 'TANKS' B'HAM.



THE PERIODICAL, TRADE PRESS & WEEKLY NEWSPAPER PROPRIETORS ASSOC.
P.T.P. & W.N.P.A.

EMBRACES ALL LEADING TRADE & TECHNICAL JOURNALS

NEW MARKETS ?

EACH of the Journals specified below has close contact with the Industries it serves, and provides the most authoritative source from which technical details and first-hand trade information can be obtained as well as the key to new markets for manufacturers of every class of product.

Aeroplane.
Architect and Building News.
Architects' Journal.
Architectural Review.
Boxmakers' Journal and Packaging Review.
Brewers' Journal.
British Export Gazette.
British Export Journal.
British Journal of Photography.
British Printer.
Caterer and Hotel Keeper.
Chemist and Druggist.
Commercial Motor.
Cycling.
Dairyman.
Drapers' Record.
Electrical Engineer.
Electrical Industries.
Electrical Review.
Engineer.
Engineering.
Engineering and Boiler House Review.
Grocer and Oil Trade Review.
Grocers' Gazette and Provision Trades' News.
Iron and Steel.
Ironmonger.
Laundry (The Power).
Licensing World.
Light Car.
Light Metals.
Locomotive, Railway Carriage and Wagon Review.
Machinery.
Mechanical Handling.
Mechanical World and Engineering Record.
Men's Wear.
Metal Industry.
Mine and Quarry Engineering.
Modern Transport.
Motor.
Motor Boat and Yachting.
Motor Cycle and Cycle Trader.
Motor Cycling.
Motor Ship.
Motor Trader.
Motor World and Industrial Vehicle Review.
Oil Engine.
Outfitter.
Petroleum Times.
Plastics.
Practical Engineering.
Printers', Etc., Sales and Wants Advertiser.
Roads and Road Construction.
Shipping World.
Silk Journal and Rayon World.
Specification.
Textile Manufacturer.
Textile Recorder.
Tobacconist and Confectioner.
Welding Industry.
Wine and Spirit Trade Review.
Wireless and Electrical Trader.
Women's Wear News.
World's Carriers and Carrying Trades' Review.

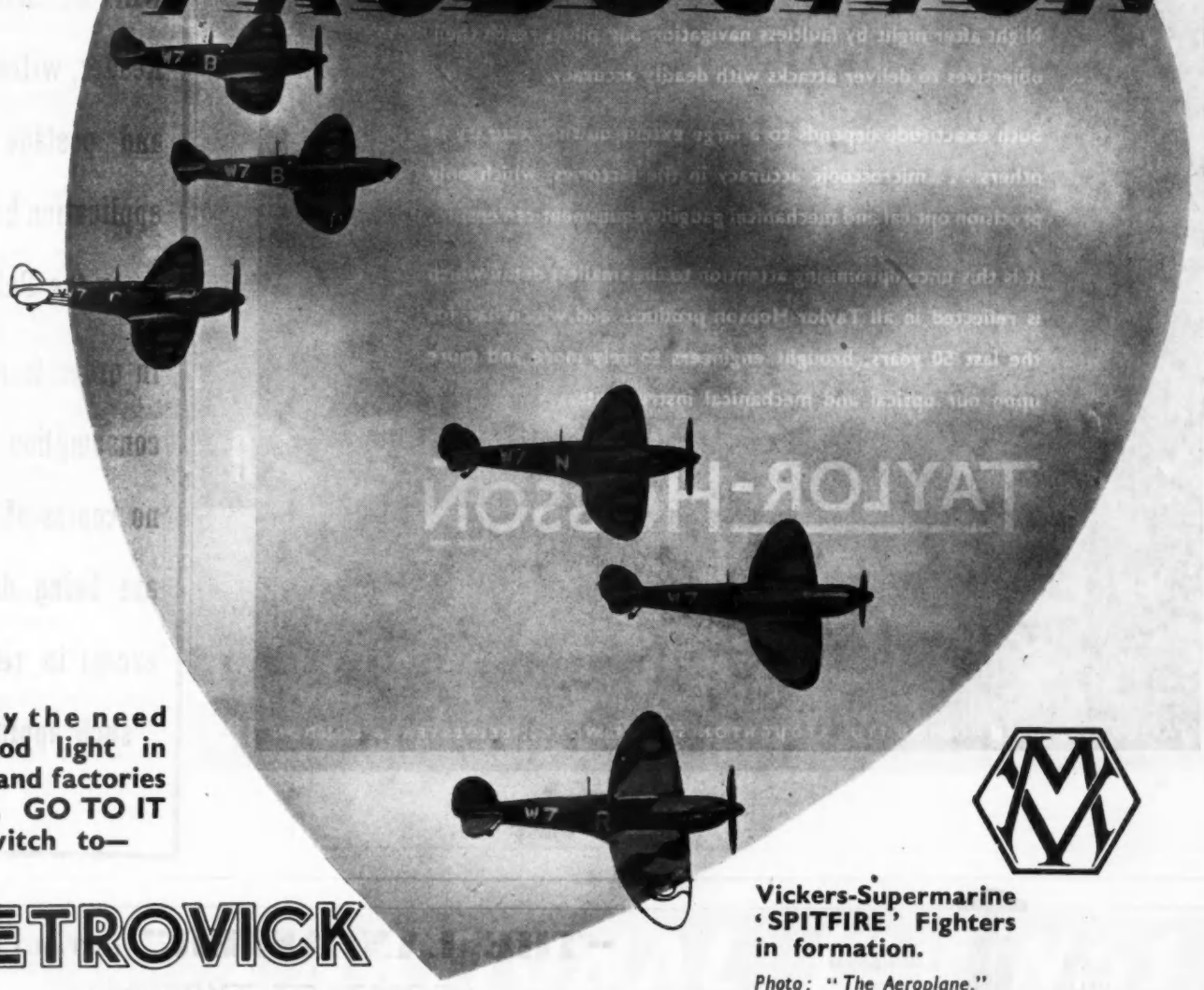
One or more of these 'Association' Journals holds the Key.

Telephone: Central 2441, 7996.
Telegrams: Weneppa, Fleet, London.

PERIODICAL, TRADE PRESS & WEEKLY NEWSPAPER PROPRIETORS' ASSOCIATION LTD.
6, Bouverie Street, London, E.C.4.

Official Handbook (Price 1/-) Essential Reference for Every National Advertiser.

Good Lighting — at the Heart of PRODUCTION



To-day the need for good light in works and factories is vital. GO TO IT and switch to—

Vickers-Supermarine 'SPITFIRE' Fighters in formation.

Photo: "The Aeroplane."

METROVICK AND COSMOS LAMPS

METROPOLITAN-VICKERS ELECTRICAL CO., LTD.
NUMBER ONE KINGSWAY, LONDON, W.C.2.

S/A090

ACCURATE THEMSELVES

— they Depend on the Accuracy of Others

Night after night by faultless navigation our pilots reach their objectives to deliver attacks with deadly accuracy.

Such exactitude depends to a large extent on the accuracy of others . . . microscopic accuracy in the factories, which only precision optical and mechanical gauging equipment can ensure.

It is this uncompromising attention to the smallest detail which is reflected in all Taylor-Hobson products and which has, for the last 50 years, brought engineers to rely more and more upon our optical and mechanical instruments.

TAYLOR-HOBSON (TRADE MARK)

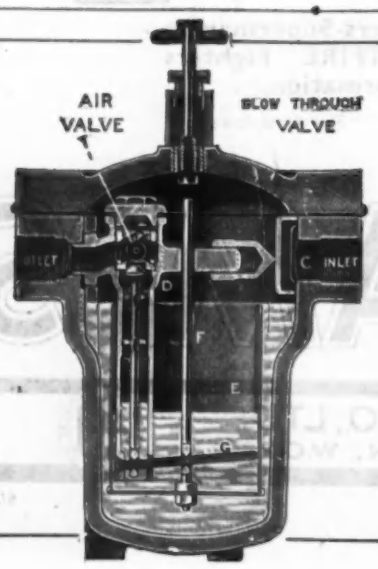
TAYLOR TAYLOR & HOBSON LTD., STOUGHTON STREET WORKS, LEICESTER; & LONDON

Pitchfords 2000

"ENGINEERING" INDEX

The Editorial Index to Vol. 149 (January—June 1940) is now ready and will be sent to any Reader, without charge and postage paid, on application being made to the Publisher.

In order to reduce the consumption of paper, no copies of the Index are being distributed, except in response to such applications.



"THE LANCASTER" (R.T.M.)

COMPACT TYPE

STEAM TRAP

Has a sharp mechanical action giving a heavy discharge—Will lift its discharge water.

Fitted with Automatic Air Valve and nickel Valves and Seating.

LANCASTER & TONGE LTD.

Telegrams: "Pistons, Manchester." PENDLETON, MANCHESTER. Telephone: PENdleton 1484 (3 lines)

7839

DAWSON & DOWNIE
OLYDEBANK LTD.
PUMPS 3151
FOR LAND and MARINE PLANTS
SEE ILLUSTRATED ADVERT., PAGE 4, Dec. 20.

HANDLING EQUIPMENT
VAUGHAN
THE VAUGHAN CRANE CO., LTD. OPENSHAW, MANCHESTER, 11.

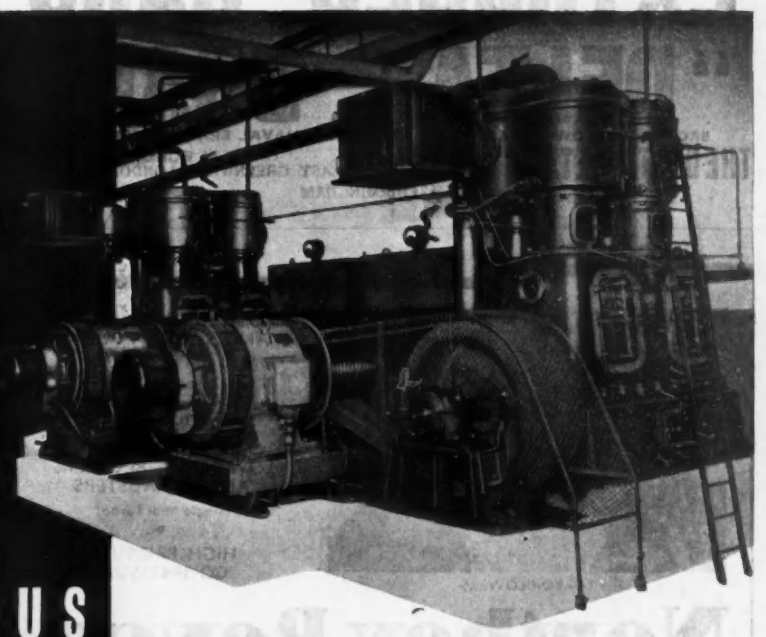
F. H. WAKELIN, LTD.
Calculator Specialists
PRINTERS AND PUBLISHERS.
354 Wheeler Street, Birmingham, 19
Reckoners for Engineering Trades
47 hour Wages, Holiday Pay Percentages, Weights, etc.
Send for Catalogue. Stating Requirements.

WALTER. W. COLTMAN & Co. Ltd
VERTICAL BOILERS
LOUGHBOROUGH

THE METALLIC VALVE Co. Ltd.,
162, INDIA BUILDINGS,
LIVERPOOL, 2.

MANUFACTURERS OF KINGHORN PATENT VALVES FOR PUMPS AND HOERBIGER PATENT VALVES AND RING PLATE VALVES OF ALL DESCRIPTIONS FOR COMPRESSORS, BLOWING ENGINES, SCAVENGE PUMPS, ETC.

CONTINUOUS HIGH OUTPUT WITH ABSOLUTE RELIABILITY



The long and specialised experience behind the design and construction of "Broomwade" Air Compressors ensures high and maintained efficiency and reliable service throughout a long working life.

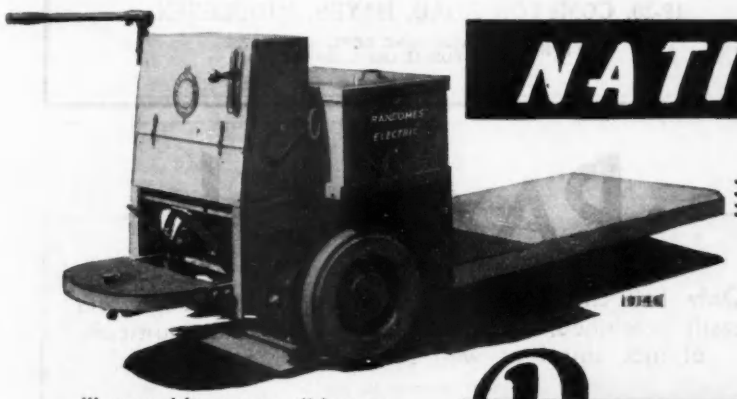
The illustration shows two "Broomwade" T.S.3. Type, Two-Stage Double-Acting Air Compressors, with motor drive, each delivering 955 cu. ft. free air per minute at 120 lbs. per square inch pressure; part of one "Broomwade" Compressor installation at the works of Vauxhall Motors, Ltd.

Write for Catalogue 'D.'

"BROOMWADE" AIR COMPRESSORS

BROOM & WADE LIMITED. HIGH WYCOMBE. ENGLAND. TELEPHONE 1630 (6 LINES)

® 39-196A



Illustrated literature will be sent on application.

RANSOMES, SIMS & JEFFERIES, LTD. IPSWICH, ENG.

NATIONAL SAVINGS!

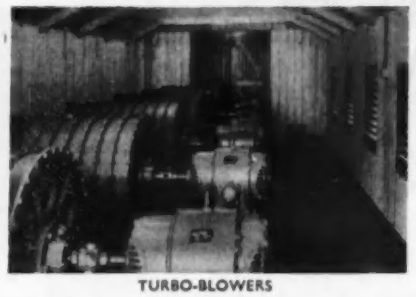
Save —PETROL —LABOUR —TIME —MONEY

Ransomes ELECTRIC INDUSTRIAL TRUCKS

EXTRUDED BARS
"DELTA" BRAND

BRONZE, YELLOW METAL, BRASS, RED METAL, NAVAL BRASS, COPPER, &c.

THE DELTA METAL CO., LTD., DELTA WORKS, EAST GREENWICH, LONDON, S.E.10.
And at BIRMINGHAM 1066



TURBO-BLOWERS

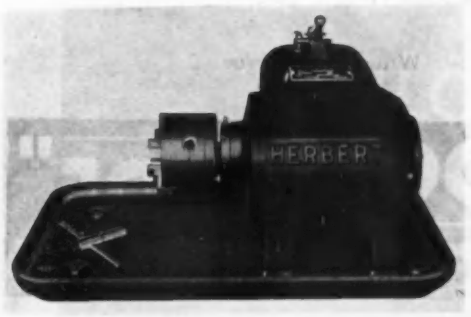
ROTARY COMPRESSORS AND VACUUM PUMPS
(Oil free or lubricated)
•
RECIPROCATING COMPRESSORS
•
LOW PRESS : BLOWERS AND EXHAUSTERS
(Single and Turbo)
•
HIGH PRESSURE COMPRESSORS

Northey-Boyce

ATTERCLIFFE COMMON, SHEFFIELD
Phone : Attercliffe 41141.

ALFRED HERBERT LTD. COVENTRY

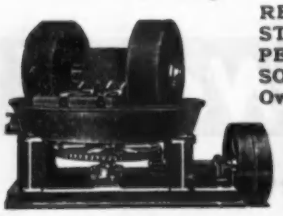
HERBERT ELECTRIC UTILITY HEAD



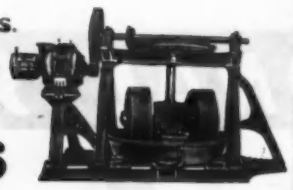
- A TIME SAVER FOR THE FITTING DEPARTMENT.
- ENABLES PARTS TO BE POLISHED OR REDUCED IN DIAMETER OR LENGTH ON THE SPOT.
- 60 IN USE IN OUR OWN WORKS.

PROMPT DELIVERY

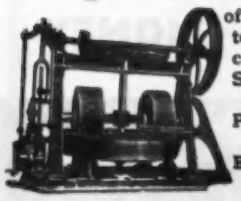
Smedley Brothers Ltd., BELPER, DERBYSHIRE, ENGLAND.



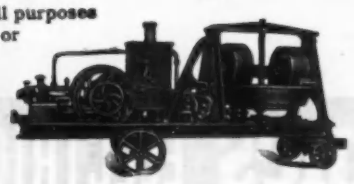
REVOLVING or STATIONARY PANS.
PERFORATED or SOLID BOTTOMS
Over or Underdriven



Mixers
AND
Edge Runner Grinding Mills



of all kinds for all purposes to drive by Belt or combined with Steam, Oil or Petrol Engine or Electric Motor.



Classified Advertisements continued from Page 3.

APPOINTMENTS OPEN.

I.C.I. (GENERAL CHEMICALS) LIMITED.

POWER DEPARTMENT.

Applications are Invited for the POSITION of SHIFT MANAGER in the Company's Power Stations.

The duties will comprise the management of a shift operating modern power-station equipment, including high-pressure water-tube boilers, turbo-alternators, E.H.T. switchgear, etc., and applicants, who should be not less than 33 years of age must have had several years responsible experience in such work, following a sound practical and technical training in mechanical and electrical engineering.

The commencing salary is £400 per annum, the appointment is subject to a three months' probationary period, and the selected candidate will be required to pass a medical examination.

Applications, giving age and full particulars of education, engineering training and power-station experience, should be addressed to I.C.I. (GENERAL CHEMICALS), LTD., Power Department, c/o CASTNER-KELLNER WORKS, Weston Point, Runcorn, Cheshire, marked "S.M." L 35

See also Page 3.

SITUATIONS WANTED.

Experienced General Manager and Engineer, SEEKS RESPONSIBLE APPOINTMENT. Fit and active.—Address, L 36, Offices of ENGINEERING.

See also Page 3.

FACTORY WANTED.

Manufacturers of essential commodities URGENTLY REQUIRE FACTORY, 10,000 sq. ft. or over, with all transport and supply facilities nearby. Natural water supply advantageous. Would share larger factory offering these facilities in right location. Urgent.—Address, L 32, Offices of ENGINEERING.

PATENTS.

The Owner of British Patent No. 400,259, relating to "Improvement in Process of and Apparatus for Refining Metals," is DESIROUS of ENTERING into NEGOTIATIONS with one or more firms in Great Britain for the purpose of exploiting the invention either by the Sale of the Patent or by the grant of Licences on reasonable terms.—Interested parties who desire further particulars should apply to ALBERT L. MOND & THIEMANN, of 14-18, Holborn, London, E.C.1. L 33

FOR SALE.

THOS. W. WARD LIMITED.

HORIZONTAL PLANO TYPE SURFACE GRINDER. Table 66 in. by 12 in. Belt-driven. By KENDALL & GENT.

HORIZONTAL SPINDLE SURFACE GRINDING MACHINE. Hydraulic feed to table; table 50 in. by 11 in.; motor-driven. By JOHN LUND.

92L. Type HEAVY DUTY VERTICAL SPINDLE SURFACE GRINDING MACHINE (LUMSDEN). 26 in. diameter rise and fall circular head. 60 in. diameter rotary table.

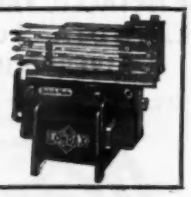
Write for "Albion" Catalogue.
ALBION WORKS, SHEFFIELD.
'Grams, Forward, Sheffield. 'Phone 26311 (15 lines)

Portable Coal Elevator for SALE. Morris, Model A, new September, 1938. Lift 11 ft. Slant height 25 ft. Slatted rubber belt. 10 tons per hour. 2-h.p., 750 r.p.m., 3 phase, 440v., totally-enclosed motor. May be inspected on application to the GENERAL MANAGER, HULL CORPORATION ELECTRICITY DEPARTMENT, FERENSWAY, HULL, to whom Offers should be delivered not later than Monday, 6th January, 1941, in plain sealed envelopes bearing no name or mark indicating the senders and endorsed "Elevator." L 34

See also Page 3.

RELAYS
ask for leaflet SPN/EN
LONDEX LTD.

ANERLEY WORKS,
207, ANERLEY ROAD, LONDON, S.E.20.
Type LQA Tel. SYDenham 6258/9 Type LF



ENGINEERING DIRECTORY

The current edition will be sent gratis on application to the Manager.

It is compiled from current advertisers in ENGINEERING and also contains the Telegraphic addresses, Key to same, Telegraph Codes, Telephone Numbers and List of Trade Names used by Advertisers.

There is also a Glossary of Equivalents in German, French, Spanish and Italian.

ENGINEERING

Temporary Address:
18-20, COMPTON ROAD, HAYES, MIDDLESEX.

TELEPHONE: ADVERTISING DEPT., HAYES 1723
EDITORIAL DEPT., HAYES 1730

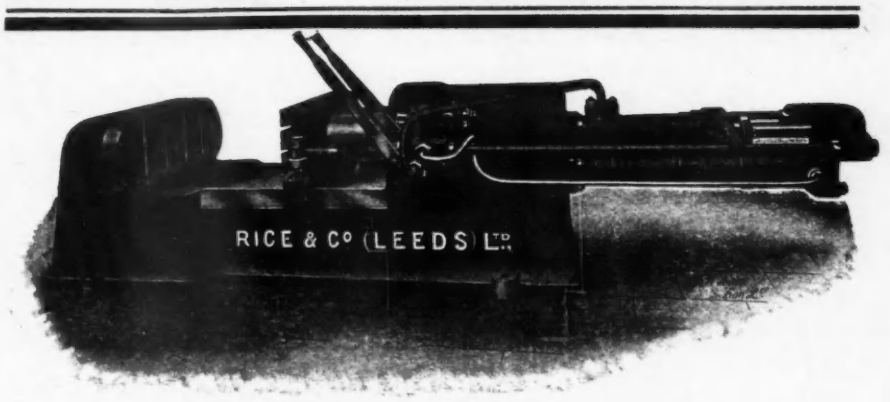
PAXOLIN
Registered Trade Mark

Only half the weight of Aluminium, yet tough and easily machined, "Paxolin" lends itself to a multitude of mechanical as well as electrical applications.

Write for Pamphlet No. PN-1/38

THE MICANITE & INSULATORS COMPANY, LIMITED.
WALTHAMSTOW Telephone: LARkswood 1044 (Pte. Br. Exch.) LONDON, E.17.

RICE HYDRAULIC MACHINE TOOLS



DOUBLE POWER STRAIGHTENING & BENDING PRESS.

PRESSES FOR FLANGING & FORMING WHEEL FORCING, ETC.

RIVETERS, FIXED AND PORTABLE ACCUMULATORS, PUMPS, ETC.

LONDON :
49, Queen Victoria St., E.C.4
TELEGRAMS } CITY
PHONE } 7546

RICE & CO. (LEEDS) LTD.

NEVILLE WORKS,
ELLAND ROAD, LEEDS, 11.

Telephone : HUNSLET 75305.
Telegrams : "PRESS, LEEDS."
Code : ABC (5th and 6th Eds.)

MILLING CUTTERS
END MILLS & REAMERS
ENGINEERS SMALL TOOLS

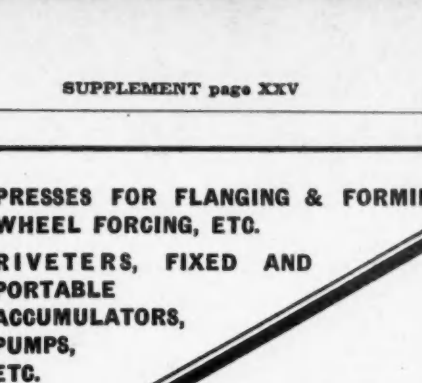
TEL:- ADDRESS
DRILLS SHEFFIELD

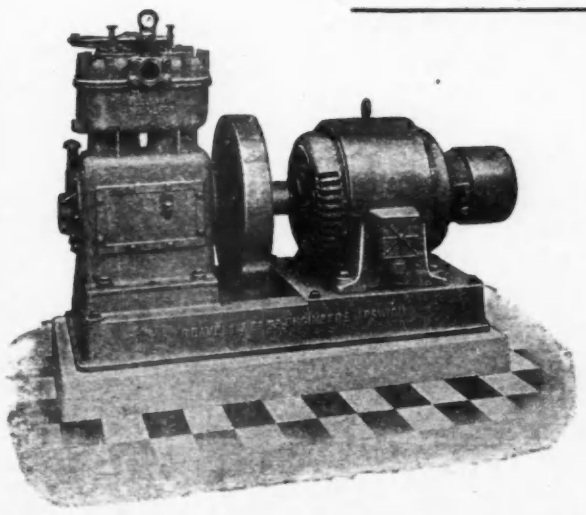
THE STALKER DRILL WORKS LTD DRILL SQ SHEFFIELD 6

AIR COMPRESSORS

VERTICAL SINGLE-ACTING TYPE.

Two-stage compressors similar to that illustrated on the right are made in two types for pressures up to 450 and 1000 lbs. per square inch. They are belt driven or direct coupled to electric-motors, petrol or Diesel Engines.





Single-stage compressors similar to that shown on the left are suitable for pressures up to 100 lbs. per square inch. They are made with one, two or three cylinders, according to the capacity required, and are driven in the same way as the machines above.

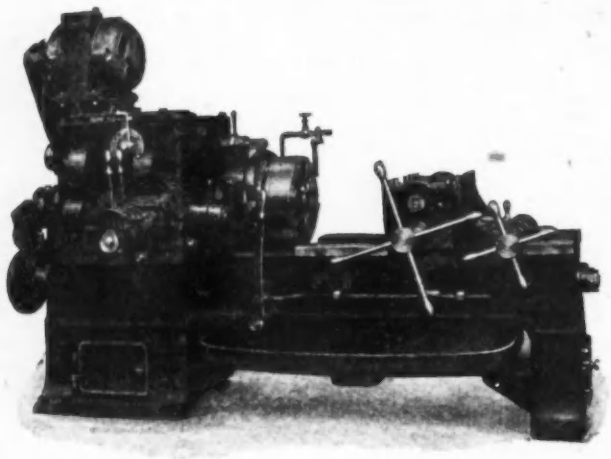
For full information write, giving particulars of the duty required, to Department "B."

REAVELL & CO., LTD., IPSWICH.

Telegrams : "Reavell," Ipswich. *Telephone Nos. : 2124 & 2125.*

Heap's Patent Screwing Machines

with Tangential Dies



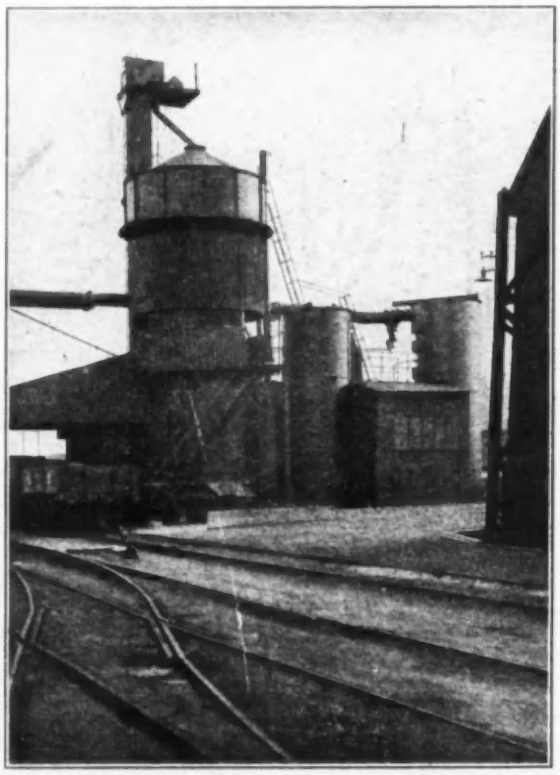
Catalogue free on request

- They are designed from beginning to end as high-class Machine Tools and embody features not found in any other make of Screwing Machine.
- The Die Head is of our own Patented Design.
- All parts of the Head and also of the Die Holders which are liable to wear, are of hardened Steel.
- The wall of metal which surrounds the Die Holders solidly supports them, and also eliminates the Danger of the Operator being caught by protruding Die Holders.
- The four-throw cam is fitted with Hardened Steel Strips.
- The Hardened Steel Contact Blocks of the Die Holders bear for their full width on the Cams.
- These features render the Die Head when closed as rigid as a solid Die, and enable us to guarantee the Heads to screw perfectly parallel and uniform threads.

Joshua Heap & Co., Ltd.

Ashton-under-Lyne, England

7101



Fully automatic BENZOGAS plant producing gas for normalizing furnaces and annealing covers. Producing clean, cold gas ready for distribution throughout works in steel pipes and through small burners. Gas cleaning plants can be supplied separately.

BENZO GAS PLANTS

IN COURSE OF ERECTION
HAVE A CAPACITY OF

1,500,000 CUBIC FEET PER HOUR

BENZO GAS PLANTS ALREADY
IN OPERATION IN GREAT BRITAIN
ONLY HAVE A CAPACITY OF OVER

2,500,000 CUBIC FEET PER HOUR

WATCH BENZO GAS PLANTS GROW

THE INTERNATIONAL FURNACE EQUIPMENT Co. LTD.

ALDRIDGE, STAFFS. *Telephone:* Aldridge 52371.

723

ASQUITH

HALIFAX

ENGLAND

THE WORLD'S LEADING
DRILLING, BORING & MILLING
MACHINE SPECIALISTS

MACHINE TOOLS of QUALITY

ESTABLISHED 1865

SOLE DISTRIBUTORS FOR THE BRITISH ISLES:
DRUMMOND (SALES) LTD.
KING EDWARD HOUSE, NEW ST., BIRMINGHAM, 2

ASQUITH OVERSEAS SALES & SERVICE
DEPOTS THROUGHOUT THE WORLD.
LONDON OFFICE, HALIFAX HOUSE, STRAND, W.C.2

979

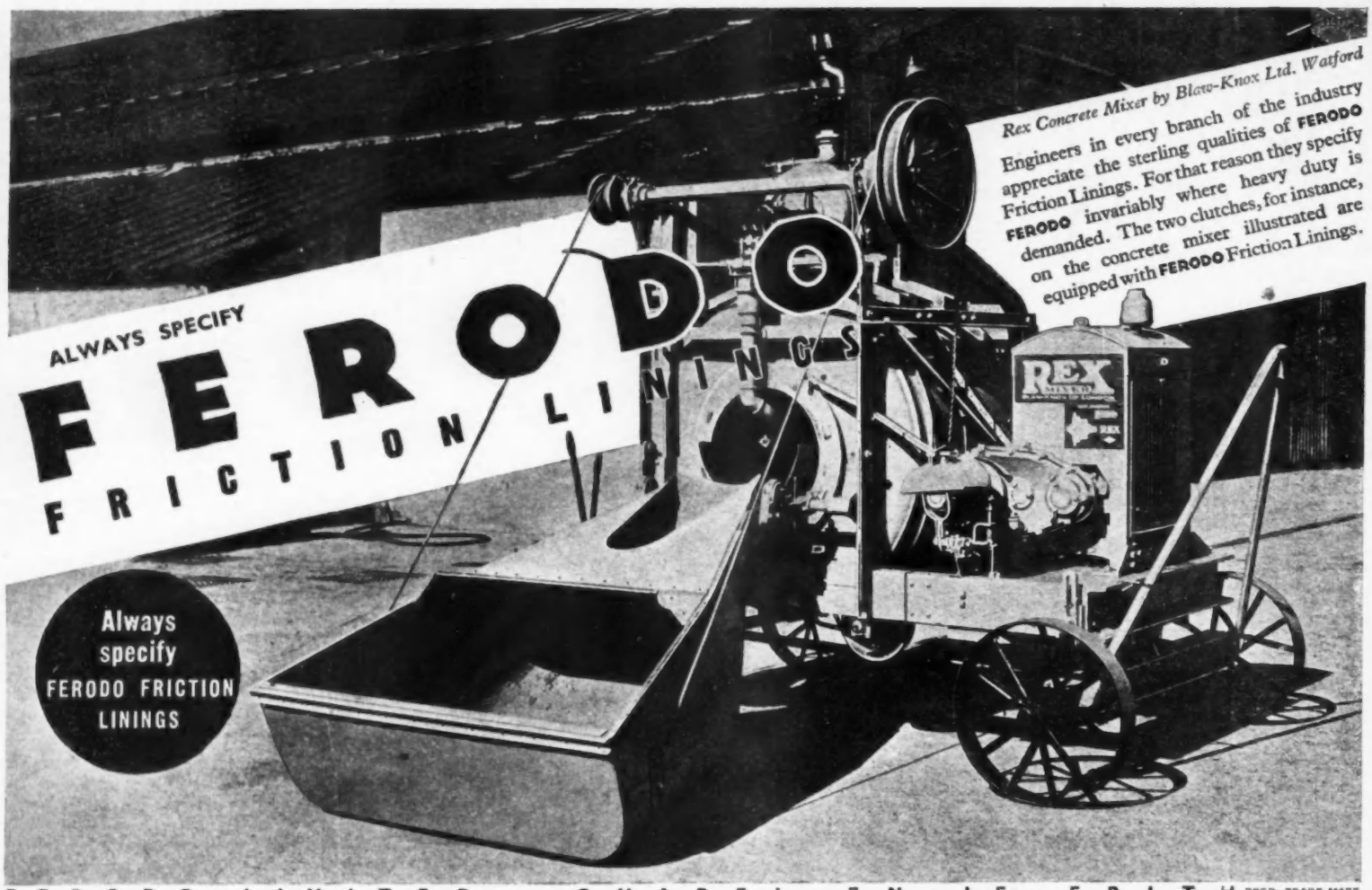
RAILWAY SIDINGS
CONSTRUCTED & MAINTAINED

SEND YOUR PLANS OR ASK US TO COME AND SEE YOU

LARGE STOCKS OF RAILS AND ACCESSORIES.

Phone: 26311 (15 lines)
Grams: Forward Sheffield.

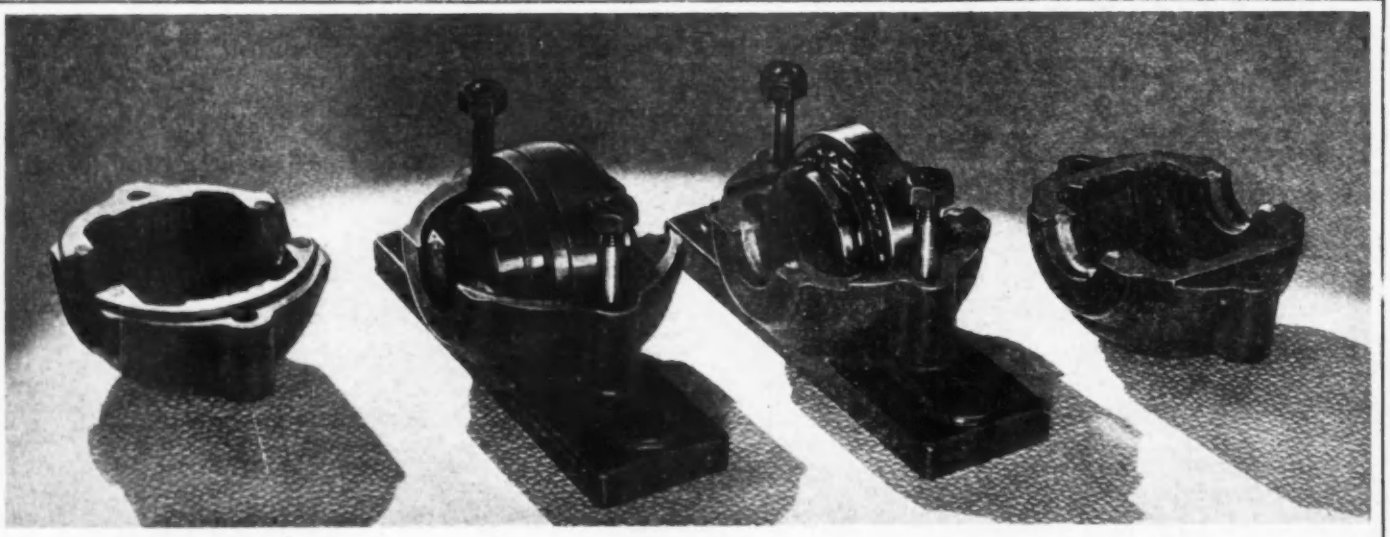
THOS. W. WARD LTD.
ALBION WORKS, SHEFFIELD.



Rex Concrete Mixer by Blaw-Knox Ltd. Watford

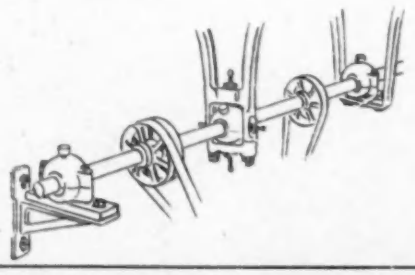
Engineers in every branch of the industry appreciate the sterling qualities of **FERODO** Friction Linings. For that reason they specify **FERODO** invariably where heavy duty is demanded. The two clutches, for instance, on the concrete mixer illustrated are equipped with **FERODO** Friction Linings.

FERODO LIMITED · CHAPEL-EN-LE-FRITH REGD. TRADE MARK FERODO



BALL & ROLLER R&M BEARINGS

for Lineshafting Save Power and Reduce Maintenance Charges



RANSOME & MARLES BEARING C°L^TD NEWARK ON TRENT ENGLAND

Printed in Great Britain for the Proprietors by HARRISON & SONS, LTD., at the Bedford Press, 20 & 21, Bedfordbury, in the Parish of St. Martin-in-the-Fields, and Published by JOHN ALEXANDER DIXON at the Offices of ENGINEERING, 35 & 36, Bedford St., in the Parish of St. Paul, Covent Garden, both in the County of Middlesex.—Dec. 27, 1940. Entered as second-class matter Dec. 12, 1896, at the Post Office, New York, U.S.A.